DISCOVERY

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Editorial Notes.

A NEW analysis of our subscription list shows that *Discovery* travels each month to more than forty countries. We have, of course, many readers in each of the Dominions, but copies also go as far afield as Bangkok, Buenos Aires, and Tahiti. Arising out of this world-wide distribution, we receive many interesting letters: in particular, articles on tropical science always bring us comments from overseas readers. Foreign correspondents, on the other hand, are usually deterred by the language difficulty from sending us their views, but a notable exception must be recorded this month. On another page we print a communication from a Danish reader, who, prompted by a recent article on bird-marking, has forwarded us new data of great importance, hitherto kept secret even from ornithologists. As most people know, the chief source of information on bird migration is "ringing." Birds caught at various stations are marked with distinctive rings, which indicate the duration and length of flight when the birds are recovered in other parts of the world. Pleading for the rationalization of this work, Mr. Nicholson suggested in *Discovery* that a station was needed in Iceland, an important centre of bird life. Now comes the news that ringing is already in progress there on a large scale, and the results are published for the first time in our columns. Mr. Skovgaard's ringing station in Denmark is recognized as one of the foremost in Europe, and Iceland is Danish territory. The work is thus a natural extension, but up to now it has been unknown to investigators elsewhere. Apart from the value of the statistics themselves, the new facts they reveal about bird habits will interest a very wide public.

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A suggested alteration in the law governing medical patents has given rise to the keenest discussion among doctors and chemical research workers. Under the new law, the inventor of a medical preparation would receive no monetary reward so far as his rights in this country are concerned. He would be entitled instead to a free licence, other licences to be granted by proposed Medical Patents Trustees for a consideration, such consideration to revert to the Trustees and not to the inventor. Those supporting this change urge that it is ethically undesirable for medical practitioners conducting research to derive financial benefit therefrom. Others strongly disagree with this view. Dr. Renshaw, for example, writes in the *British Medical Journal* that there is no essential difference in the nature of the service to mankind between the skill of the laboratory worker and that of the surgeon who, for his skill, takes a fee. "If the research worker can, by his skill and ingenuity, add to the sum of human happiness and health," he asks, "why should he not be paid, when the administrator of a public health service, who may utilize his results, is paid for so doing?" We think that the best solution is suggested by the Joint Chemical Committee, which holds that the abandonment of medical patents should not be adopted until international agreement has been obtained. Otherwise both research workers and manufacturers in this country would be placed at a very considerable disadvantage.

* * * * *

Further progress in physical theory was announced by Professor Einstein last month, when he gave an address to the world Power Conference in Berlin. The occasion was interesting on account of a new speaking apparatus, used for the first time, by which the lecture could be heard in any of three languages. (Photographs on another page show the apparatus at work.) The title was "The Space, Field, and Ether Problem in Physics." As was expected, the address was extremely technical and only expert

mathematicians could appreciate its significance. According to an official report, however, the Professor summed up the position as follows: "Metaphorically speaking," he said, "space which had been abstracted from material objects and made a scientific reality by Newton has, during the past century, swallowed up both ether and light, and is about to swallow up both the gravitational and electro-magnetic fields and corpuscles as well, so that it will be left as the sole theoretical representative of reality."

* * * * *

A well-known cartoonist, in connexion with the Simon Report, recently showed India as a giant elephant. "All we have to do," the Government was saying, "is to place him on the operating table" What gave the artist the idea we do not know, but actually an elephant *was* treated in this way not long ago. The animal, a captive beast employed on a rubber estate, had become restive and dangerous, owing to what appeared to be the lodging of a foreign body in his head. Accordingly arrangements were made to have Jumbo X-rayed. After a march in easy stages he reached Columbo General Hospital, where he was examined in the presence of a large body of the medical profession, press representatives, and other spectators. There was a nervous moment when the elephant tried to touch the delicate Philips X-ray apparatus with the tip of his trunk, but he remained passively philosophical during the examination. The photographs revealed a small bullet, probably fired at him during his wild career in the jungle, which had penetrated his skin near the ear. It was later successfully removed.

* * * * *

How a ruthless war against insect pests in every part of the Empire is being directed from a headquarters in a Buckinghamshire village is described in a report just issued by the Empire Marketing Board A converted country-house at Farnham Royal, near Slough, is used as a clearing station and breeding centre for "beneficial" insects. These are dispatched to the Dominions and Colonies to attack their harmful brothers, who cause an enormous loss to agriculture. In the three years of its existence, this "Parasite Zoo" has been asked by overseas Governments to investigate some seventy different kinds of insect and weed pests, in the hopes that parasites may be found. Damage done by insects is extremely costly. Blowflies, for instance, annually destroy about five per cent of the sheep population of Queensland, and are estimated to cost Australia £4,000,000 a year. The insect toll is likely to grow bigger in future. The majority of the serious pests are not native to the countries they now infest. They were introduced, accidentally or otherwise, by man, and the more we foster Empire trade, the more opportunity we give to injurious insects to move from one part of the Empire to another. Cunning devices have been invented by entomologists to deal with the problem. One of these is called a "bouncing machine." Tiny insects' eggs are allowed to run down a wooden chute and bounce off a small piece of tin at the bottom. An egg which has been "parasitized"—that is, which has another egg, laid by the parasite, inside it—does not have the same capacity for bouncing as do healthy eggs, which jump into a further tin and so are separated for laboratory purposes.

* * * * *

The possibility of establishing an Arctic air route between Britain and Canada will be carried a stage further this summer. On 3rd July an expedition will leave England to explore the Arctic ice cap of Greenland, under the auspices of the Royal Geographical Society and various Government interests. The party will sail in the *Quest*, at one time used by Sir Ernest Shackleton, and is being led by Mr. H. G. Watkins, of Cambridge. The special advantage of the proposed route is that the longest stretch of flying over the sea which it involves is only three hundred miles.

* * * * *

The wireless telephone service to ships at sea, established by the Post Office experimentally last February, is making excellent progress. Before long it is probable that passengers on any of the principal liners will be able to ring up telephone subscribers in almost any country in the world. Meanwhile, the remarkable quality of the service already working was shown last month when the B.B.C. broadcast a conversation between a passenger on the *Homeric*, in mid-Atlantic, and a speaker in the London studio. Every word of the passenger's description of the scene on the liner was as clearly heard as the questions and comments put to him from London. The absence of the annoying hum or crackling, which sometimes ruins long-distance telephony even over wires, was particularly noticeable.

* * * * *

The following conversation is reported in the Oxford *Isis*. We think it may form a suitable footnote to our paragraph about Einstein!

First Don: I say there is *no* meaning in meaning.

Second Don: You mean no meaning in what meaning is meant to mean.

First Don: I don't. I mean there may be meaning in what meaning is *meant* to mean but no meaning in what meaning *means*.

Second Don: Ah, yes; now I see what you mean.

Mummy Mining in Peru.

By A. Hyatt Verrill.

The mining of human remains has been an established Peruvian industry for hundreds of years, in the course of which countless mummies have been disinterred. The country is still proving an important field for archaeological research, and the remains of ancient races are continually brought to light.

EVER since the days of the Spanish conquest, mining mummies has been a more or less lucrative industry in Peru. Not that the mummies themselves were desirable or valuable, but because the Incans and pre-Incans interred ornaments, weapons, utensils and implements with their dead, and some of these were of gold or silver. How many tens of thousands of mummies were thus destroyed no one can guess. In addition to the countless mummies dug up by the professional *huaqueros*, as they are called, thousands of bodies have been disinterred by archaeologists, curio-seekers and others, while thousands more have been destroyed in the course of constructing railways and roads, digging irrigation-ditches, cultivating land and carrying on various public and private works.

A PRE-INCAN MUMMY.
This specimen was discovered clad in its ceremonial robes and adorned with golden ornaments

One would think that, years ago, the supply of mummies would have been exhausted But so vast was the number of dead buried in Peru that, despite all that have been disinterred, practically no impression has been made, and what is more, scientists are continually finding mummies and remains of hitherto unknown people and cultures. No one would dare to estimate the number of mummies that were buried or that yet remain even in a small area of the country. From Ecuador to Chile and from the coast to beyond the Andes there is scarcely a square mile without its cemeteries, its mounds or its ruins filled with dead. Many cemeteries cover hundreds of acres; many burial-mounds are stupendous; and in many ruined cities every available piece of ground is filled with mummies. The Huaca Juliana, just outside of Lima—nearly half a mile in length, nearly a quarter of a mile wide, and over one hundred feet in height—is made up of countless brick cubicles containing mummies, and this is but one of numerous equally huge burial-mounds in the vicinity. The new urbanization developments about Lima are surrounded by burial-mounds; one of the new highways cuts through the centre of an immense mound filled with mummies, and a suburb has been erected over ancient grave-yards. It is not unusual to see a modern residence with scattered skulls, scalps, mummy-wrappings and bones within a few feet of the front door, and in cultivating their flower gardens the residents are as likely to turn up skulls as stones.

Obviously the majority of the mummies are those of poor and humble peasants, for as a rule the mummy-bundles contain very little of value or interest. Stone, shell or clay ornaments, an occasional stone implement, gourds filled with corn, peanuts or other food; baskets of needles, thread and weaving implements, pouches filled with cotton seeds, llama-hair slings and cotton spindles are the usual objects found, together with pieces of pottery and various kinds of cloth. But if one is fortunate enough to disinter the mummy of a chief, priest or medicine-man, a wonderful collection of archaeological treasures may result. At times they are found with elaborate head dresses of feathers; there is usually a mask or false face of painted inlaid wood or even of silver or gold; there may be bows and arrows, ceremonial staffs, spears with bronze tips, *atlatls* or spear-throwing sticks and ornaments

of silver and gold. From one grave I obtained a magnificent bronze battle-axe with handle complete, a most effective weapon still capable of slicing a man's head from his shoulders or cleaving his skull; the star-headed maces of stone or bronze, as well as bundles of *quipos* or message-strings, are quite common. If the mummy is that of a woman there will be work baskets, looms—often with partly woven textiles upon them—carded and dyed yarn, and sometimes gowns and shawls of the most delicate and beautiful lace, all so perfectly preserved that they might have been buried only yesterday instead of thousands of years ago.

In most of the coastal districts—especially in the Rimac Valley—I should say that not one in five hundred mummies is accompanied by any objects of intrinsic value, and that not one in a hundred has anything unusual as far as textiles, pottery, feather-work or utensils are concerned. Yet in other parts of Peru the proportion of richly decorated mummies is very large, and in a few localities they preponderate, while in only one known district are all these so far discovered of this type.

Despite all the archaeological work that has been done in Peru during many decades, we really know little of the ancient cultures. No one positively can say whether they all had a common origin or whether they were distinct and each race developed its independent culture. No one can assert with certainty which is the most ancient. Even the origin and history of the Incas—the most recent of all Peruvian cultures—are shrouded in mystery and uncertainty. All we do know is that in many places one culture is superimposed on another, and by the stratification of the remains we can determine the chronological order in which they were developed. Constantly we are greeted by the most amazing surprises and discoveries that often—I might say usually—result in adding to the mysteries and puzzles we are trying to solve.

This was the case in the Nasca district of southern Peru. Probably no other ancient Peruvian culture was, or was supposed to be, so well known as that of the Nascans. Practically every museum and private collection in the world contains specimens of Nascan ceramics, textiles and featherwork. Of all known aboriginal American pottery the Nascan holds first place for its beauty and perfection. Of equal beauty and perfection are the Nascan textiles and featherwork, and as a rule these are perfectly preserved with colours as fresh as when first made. This is due mainly to the fact that the Nascans buried their dead in genuine tombs instead of in graves. Each body, when of a prominent personage, was wrapped in cloths and swathed in textiles until a bundle several times the size of the body was formed. This was then arrayed in the finest of robes, ponchos, belts and textiles, adorned with silver or gold ornaments, and was provided with a mask and false head covered with human hair. It was then crowned with a gorgeous feather head dress, and the whole was enclosed in a cocoon-like wrapping of coarse cloth.

Opening a Nascan tomb is very different from digging up a mummy in a desert or a mound. Fragments of shards, bones and rubbish mark the burial-places, and the tombs are indicated by the tops of vertical posts. Below the loose superficial sand and pebbles is a small platform of sticks under

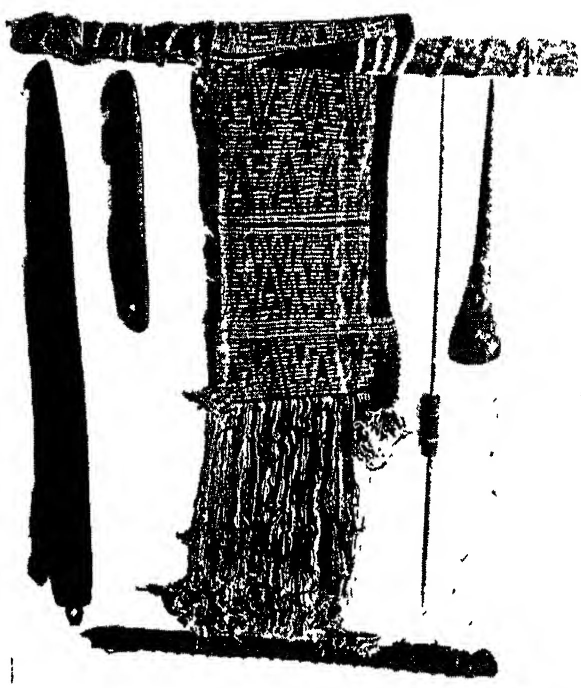
TERRA-COTTA GRAVE GODS.
It is supposed that these grotesque images of women, found in the tombs of Peru, represented the wives of the men with whom they were buried.

which is more gravel. When this has been removed for a depth of several feet a strong structure of timbers covered with stones is revealed. This is the roof of the tomb, a large square room walled with stone and adobe, and often as large as a good-sized hut. Placed upon the floor are pots, *ollas* and vessels of the beautiful Nascan ware, and in the corners, resting backs to walls, are the huge shapeless bundles each containing a mummy.

Owing to the beauty of the Nascan objects and to the abundance of precious metals in the tombs, more systematic mummy mining has been done in the Nascan area than in any other portion of Peru, for Nascan specimens always find a ready sale and professional *huaqueros* have always been able to turn an honest penny by disposing of the textiles and ceramics, even when no gold or silver rewarded them.

Yet despite this, despite the fact that practically every archaeologist who has ever visited Peru has had a fling at mummy mining at Nasca, and despite the fact that all agree the culture was unique, that it was confined to a limited area and that no other culture (other than the late Incan) occurred near Nasca, recent discoveries have completely upset all these ideas and have proved that not only was there a pre-Nascan culture, but a pre-pre-Nascan culture totally distinct from the true Nascan. These discoveries bear out what I have said regarding the ever-present chances of making epochal discoveries, even in the best-known districts of Peru.

Not only were the tombs of the pre-Nascans distinct from those of the Nascans, being cylindrical instead of rectangular, but the textiles, the pottery and the mummies were very different. As many of the Nascan burials were above the others there is no question that the Nascans were the more recent. To what extent the latter were influenced by their predecessors it is impossible to say. In some respects there is a similarity in design, in colours and in *motifs*, both in the textiles and ceramics, yet they are always distinct and easily recognized. No Nascan pottery can compare with that of the pre-Nascan. In one spot countless thousands of potsherds were found—fragments of vessels wantonly destroyed by the Spaniards. These were collected and when, with infinite labour, they were pieced together, they formed jars and bowls several feet in height, often two inches or more in thickness and completely covered, often inside as well as outside, with most intricate and beautiful designs in the colours for which Nascan ware is famed. Even more remarkable and unique were the pottery figures of llamas, two feet or more in height, beautifully modelled and coloured, and forming hollow vessels the openings of which were in the form of elaborately decorated cup-like vessels upon the animals' backs.



FROM A WOMAN'S GRAVE.

A loom, with a partly completed tapestry in the conventional fish design of pale blue, grey and buff.

In another place—though still within the Nascan area—indications of burials were found, and excavations brought to light mummies such as no one had ever seen or imagined. Unlike those of the Nascans, these of Parakas were not in tombs, not even in true graves, but had been placed, as many as forty or fifty together, in huge pits or caverns and covered with sand. As the material was removed the mummies appeared more like conical, dun-coloured tents than mummy-bundles, for they were pyramidal in form and often six feet in height by six feet in diameter at the base, and bore no resemblance to human forms. They were so huge, so bulky, and so heavy that several men were required to lift or move them, and even the smallest were larger than any Nascan mummy-bundles. In the open air they could not safely be opened, but glimpses of their contents, exposed through rents in the outer wrappings, revealed textiles of remarkable beauty.

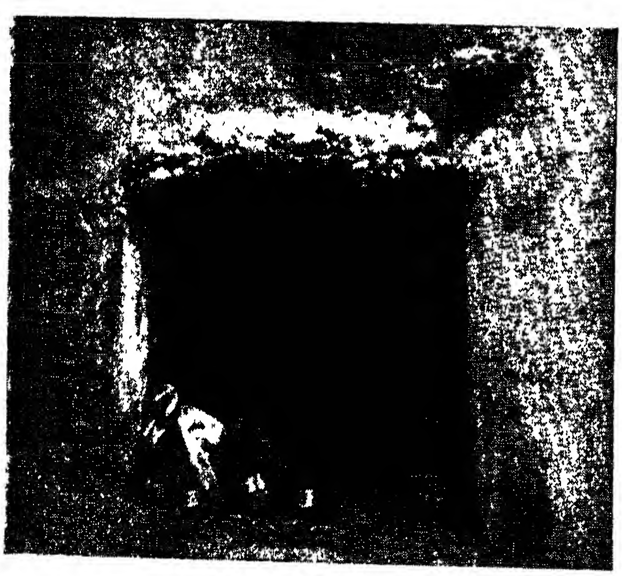
Apart from these great mummy-bundles there were specimens of pottery as unique as the mummies. Many were ornately decorated with incised designs combined with colours, others were painted in bright

yellow, green and blue with some pigment that gave the effect of oil colours; others were in the forms of fruits, vegetables, birds and animals, but all were of a type unlike anything hitherto known.

That these remains were extremely ancient was proved by representations of llamas with five toes instead of two as in the living species, and skeletons of five-toed llamas were found interred in the graves. Whether these people lived so long ago that llamas still retained five toes, or whether these llamas were a special breed, is undetermined. But at the lowest possible estimate the Parakas remains are at least two thousand five hundred to three thousand years old.

It was not until the mummy-bundles were unwrapped in the museum at Lima that anyone realized fully their tremendous archaeological value, the treasures they contained, or the epochal discovery that had been made; every bundle, in fact, was a little museum in itself. And with each section of wrappings removed our wonder and amazement increased. No two were alike in contents, and unwrapping them was like undoing a Christmas package, or a game of archaeological grab-bag. It was impossible to foretell what might be within the wrappings, for neither the size nor the external appearance of a bundle afforded any guide as to its contents, and very often the largest bundles held less than the small ones.

Moreover, instead of having the textiles, weapons, ornaments and other objects all together, as is the case with other Peruvian mummies, these from Parakas are covered with a series—strata might better express it—of alternate wrappings and



A TOMB AT NASCA.
Nascan textiles and featherwork were found in perfect condition with the colours as fresh as when first woven.

DIGGING IN A BURIAL MOUND.
Mummy mining is dusty work, as this picture of operations among the tombs in the Rimac Valley clearly shows.

magnificent textiles together with the possessions of the deceased. There is no definite number of these wrappings—they vary from six to sixty or more—and as one never knows what the removal of the next wrapping may expose, the unwrapping of a Parakas mummy is extremely thrilling, at least to an archaeologist.

As a rule, when the outermost covering of rough white cotton cloth is removed, the bundle is found completely shrouded in immense, exquisitely coloured robes of fine woollen cloth with magnificent fringes. These are usually red and black—though sometimes of grey viscacha hair—woven with elaborate checks, stripes or squares, and almost completely covered with symbolic and highly conventionalized designs in yellow, blue and green heavily embroidered upon the surface. Covering the upper portion of the bundle is a short tunic or poncho of brilliant colours, while above this is an elaborate head dress of fox skin or other material and feathers. Often a collar or necklace of shells, stone beads or gold may be below this.

Carefully removing the textiles, the head-covering, the tunic and the robes, a second, a third and sometimes as many as twenty of the great embroidered shawls are revealed. Tucked among their folds are feather-fans, feather-wands, stone-headed maces, wooden ceremonial sceptres, ornaments of gold, carved stones, turquoise and shell. This, however, is only the beginning. Under the last immense robe appears a second shroud of white or brown cloth tied securely at the top to form a false neck and head, which is covered with a square of cloth, usually blue or brown. Unlacing the twine with which the shroud is held

in place, and stripping off the wrapping, another layer of brilliantly coloured textiles is disclosed. Very often these are as perfectly preserved as the first layer, but quite as frequently they are embedded in a mass of fine, dark-brown powder mingled with bits of fur and feathers, all that remain of what, thousands of years ago, were gorgeous robes and trappings.

Yet when this decomposed material is brushed and blown aside, perfectly preserved textiles are found in and beneath it. At this stage of unwrapping—provided there are not over eight or ten layers—the indistinct outlines of the body are visible through the coverings. Here also are usually the *maté*-bowls, the gourds of corn and beans; yucca-roots, potatoes and other food; stone weapons, pottery and gold ornaments. Finally, when the last covering is removed, the mummy itself appears, seated on its haunches and resting on its left side amid garments, utensils and cloths, and always in an immense shallow basket, while in some cases the basket-lid is found upon the stomach of the mummy. In the majority of cases the body is decked with gold ornaments, such as ear-plugs, necklaces, gorgets, collars, nose-rings, and head ornaments.

THE QUICK AND THE DEAD.
Suburban residences have been built upon the ancient graveyards of Lima, and are surrounded by bones and skeletons.

Of all Peruvian mummies those of Parakas are the best preserved, for unlike the others they were carefully and skilfully embalmed or mummified before burial. All the viscera and softer portions of the anatomy were removed, the larger muscles were dissected through incisions in the skin, the tendons were severed at the joints, and the entire corpse was apparently immersed in some chemical—probably a saline solution—and afterwards dried and smoked before burial. Very possibly the bodies were preserved for months or even years before burial, for it would require a very long time to weave and embroider the immense burial-robes, and as none of these show any signs of use we must assume they were made solely for burial purposes. If made after a death took place it is obvious that the body must have been preserved elsewhere until the robes were completed; but, of course, they may have been woven years in advance and laid aside in readiness for the owner's end. Or, again, they may have been religious or ceremonial robes kept in temples and intended only for burial-robes. The objection to this theory is that each mummy is surrounded with robes, ponchos, tunics, cloths and turbans all of the same colours and designs, perfectly matched and distinct from those on any other mummy. So it is clear that they must have been designed especially for each individual.

No words can do justice to the beauty, the colours or the quality of these textiles, with designs that, repeated over and over again and completely covering a robe eight or ten feet square, never vary by so much as a stitch or a thread in size, colour or pattern. So close and even is the embroidery that only by a most painstaking examination with a lens is it possible to determine that it is embroidery and not weaving. Moreover, these people were, apparently, the only ancient Peruvians who possessed a pictured or recorded calendar. On some robes the border is composed of symbolic figures so arranged that, almost beyond question, the design served as a calendar showing days, months, and the four seasons of the year.

At every turn, when studying the Parakas material, one comes face to face with insoluble mysteries. Who were these people? We know from their skeletons that they were far larger than other Peruvian races, for many of the men stood over six feet in height, while some of the women were almost as tall. Although an agricultural race, they were no mean warriors, for their stone weapons were beautifully made, and trophy-heads—heads artificially preserved, and with lips and eyelids sewn together—are not uncommon.

All the mummies so far found have been chiefs, priests, nobles or kings and their women. Not a single one was the body of a peasant. Were all the Parakans wealthy, richly-clad nobles? And where are the ruins of their homes, their palaces and their temples?

There is but one answer. What we have so far found is merely one small group of burials devoted to the most eminent members of the community, and somewhere, near at hand, we may yet find remains that will solve all these mystifying puzzles.

First Bird-Marking Results from Iceland.

By P. Skovgaard.

*Mr. Skovgaard is the head of the important Danish organization for bird-marking at Viborg. In response to the suggestion*that a centre ought to be established at Reykjavik, he discloses the fact that bird-marking has recently been carried out on a considerable scale in Iceland, and with remarkable results hitherto kept secret. In order to explain the significance of these new data, we invited Mr. Nicholson to supply a series of notes, which are printed in brackets at the appropriate points.*

In Mr. Nicholson's article there are many statements and suggestions of great interest, and among them a proposal for a ringing station at Reykjavik. One already exists, or at any rate the work is rapidly developing in Iceland. Beginning with only one assistant in 1921, it has now the help of thirty-eight assistants in seventeen different districts, and has so far marked 4,464 birds. These have yielded hitherto 124 recovery records, of which 86 were outside Iceland including 54 from Britain. I therefore suppose the results may be of special interest to the readers of *Discovery* :—

Species Marked in Iceland.

(Re-arranged according to accepted British classification.)

	Number of Birds Marked.	Recovered.
Raven, *Corvus c. corax*	9	0
Hawfinch, *Coccothraustes c. coccothraustes*	1	0
Mealy (?) Redpoll, *Carduelis l linaria*	1	0
Snow-bunting, *Emberiza nivalis* ...	45	0
Meadow-pipit, *Anthus pratensis* ...	338	2
White wagtail, *Motacilla a. alba* ...	234	2
Iceland Redwing, *Turdus musicus coburni*	160	0
Merlin, *Falco columbarius aesalon* ...	5	0
Gyrfalcon, *Falco rusticolus*	3	1
Whooper swan, *Cygnus cygnus* ...	?	0
Bean-goose, *Anser fabalis* (?)	6	0
Mallard, *Anas platyrhyncha*	58	0
Gadwall, *Anas strepera*	28	4
Pintail, *Anas acuta*	61	5
Wigeon, *Anas penelope*	294	31
Teal, *Anas crecca*	125	11
Tufted duck, *Nyroca fuligula*	52	1
Scaup-duck, *Nyroca m. marila*... ...	239	10
Barrow's goldeneye, *Bucephala islandica*	19	0
Long-tailed duck, *Clangula hyemalis*	155	2
Harlequin duck, *Histrionicus h. histrionicus*	49	1
Eider, *Somateria mollissima*	115	2
Common scoter, *Oidemia n. nigra* ...	57	3
Red-breasted merganser, *Mergus serrator*	60	2
Cormorant, *Phalacrocorax c. carbo* ...	1	0
Gannet, *Sula bassana*	?	0

*Put forward in Mr. E. M. Nicholson's article on "Rationalisation in Bird-Marking," *Discovery*, April, 1930.

Species Marked in Iceland—(*Continued*).

Great northern diver, *Colymbus immer*	2	1
Red-throated diver, *Colymbus stellatus*	3	0
Oystercatcher, *Haematopus o ostralegus*	2	0
Ringed plover, *Charadrius hiaticula*	30	0
Northern golden plover, *C. apricarius altifrons*	341	23
Dunlin, *Calidris a. alpina*	110	0
Purple sandpiper, *Calidris m maritima*	6	0
Iceland redshank, *Tringa totanus robusta*	58	0
Red-necked phalarope, *Phalaropus lobatus*	392	0
Whimbrel, *Numenius p. phaeopus* ...	174	3
Snipe, *Capella gallinago*	184	3
Arctic tern, *Sterna macrura*	409	0
Great black backed gull, *Larus marinus*	47	3
Kittiwake, *Rissa t. tridactyla*	50	0
Great skua, *Stercorarius s. skua* ...	9	0
Arctic skua, *Stercorarius parasiticus* ...	12	0
Razorbill, *Alca torda*	1	1
Guillemot, *Uria a. aalge*	89	0
Ptarmigan, *Lagopus mutus*	83	3

[In order to avoid confusion for British readers the scientific names are given according to the Check-List. A surprising feature of this impressive record is the recovery percentage of the Gadwall, Pintail, Wigeon, Teal, Scaup, and Golden Plover group, which would be creditable anywhere.]

Recovery Records Abroad of Birds Marked in Iceland.

(Dates in italics refer to recoveries more than a year after marking.)

Meadow-pipit.

1. Caught 29 x 29 at Oosthoven, Turnhout, Antwerp, Belgium.
2. Shot c 19.xi.28 at Penaroyo, Cordova, Spain.

White wagtail.

1. Caught 5.ix.28 at Rockall.

[Rockall is a bare minute uninhabited islet (lat. 57° 40′N., 13° 30′ W.), beyond St. Kilda. For a case of another first-year bird of this sub-species coming aboard twenty-four days earlier between Iceland and Rockall see *British Birds*, XXII, p. 124.]

Gadwall.

1. Shot 26.x.27 at Rye, Sussex, England.
2. Shot 27.i.29 at Currandulla, Co. Galway, Ireland.
3. Shot *12.ii 30* on Lough Glore, Co. Westmeath, Ireland.

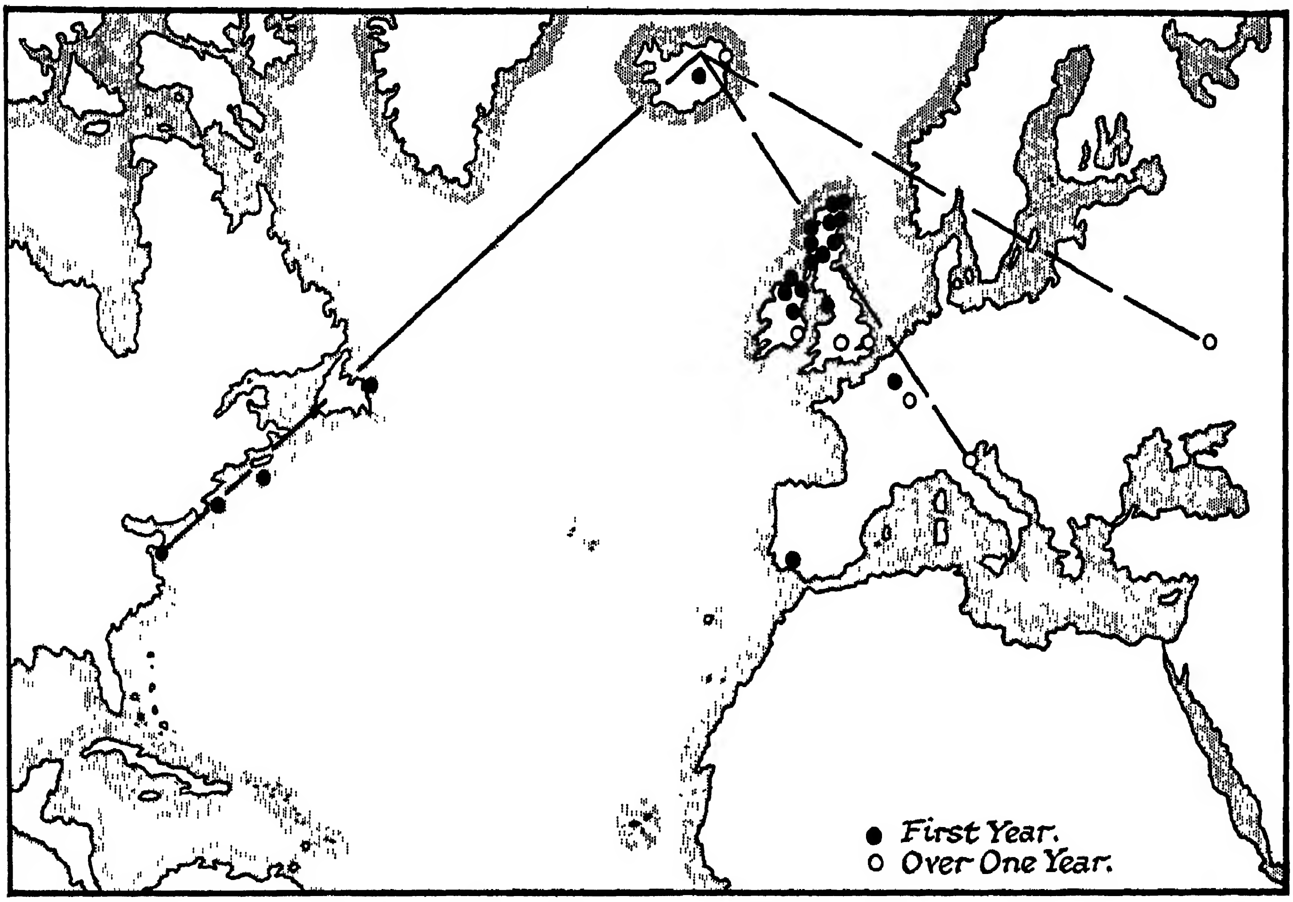


FIG. 1.
MAP SHOWING RECOVERIES OF WIGEON MARKED IN ICELAND
Out of twenty-seven recoveries abroad on both sides of the Atlantic, eighteen are in the British Isles. Although longer distances have been flown by marked swallows, white storks, etc, no other case of such broad dispersal has so far come to light (Birds recovered within one year of ringing and after are separately indicated)

[The recovery of three birds in the British Isles out of only 28 marked in Iceland is a striking case, the dates suggesting strongly that this may be the normal winter quarters.]

Pintail

1. Shot 25 ix 26 at Hornborgasjo, Västergötland, Sweden
2. Shot 8.xii 27 at Clonmorayh, Rathangan, Co Kildare, Ireland.
3. Shot *11. xii 27* on L Atalia, Co Galway, Ireland
4. Shot 16.i.27 at Ballydaheen, Castletown, Co Cork, Ireland

[The occurence in its first autumn near the Cattegat of a pintail native to Iceland is one of the most disturbing instances of the dangers of dogmatizing even from a considerable amount of marking data. Mortensen recovered 67 pintail out of 320 caught on migration at Fanö, Denmark, and a number of summer recoveries led to the conclusion that these were birds native to Scandinavia and northern Russia migrating to winter quarters south-west The possibility is now open that some may actually have been Icelandic birds travelling by an unexpectedly circuitous routé to their recovery localities in Italy and western Europe. The new position seems to be that while Icelandic pintail are now proved to winter in the British Isles it is no longer possible to assume from Mortensen's results that north European birds do the same, as Landsborough Thomson concludes ("Problems of Bird-Migration," p. 214). The Swedish bird, at the time when it was shot, must certainly have been still on its way to winter quarters.]

Wigeon

1. Shot 16 ix.27 at Acnoba, Lochgilphead, Argyllshire, Scotland.
2. Shot *25 ix 29* at Holy Island, Northumberland, England.
3. Shot 15 ix 28 on Orkney Isles, Scotland.
4. Shot 28 ix.28 at Gerston Bog, Halkirk, Caithness, Scotland.
5. Shot 5.x.27 at Stephenville Crossing, Newfoundland.
6. Shot 8 x 28 at Lesmurdie, Morayshire, Scotland.
7. Shot 9 x.28 on L. Swilly, Co. Donegal, Ireland.
8. Shot 14 x.26 on Rio Macete, Huelva, Spain.
9. Shot 19 x 29 at Rogerstown, Co. Dublin, Ireland
10. Shot *29.x 28* at Autrecourt on Meuse, Ardennes, France.
11. Shot 30.x 29 at Hamel, Nord, France.
12. Taken 2 xi 27 on Loch Eye, Ross & Cromarty, Scotland.
13. Caught *5 xi.28* in a decoy near Ipswich, Suffolk, England.
14. Shot 14 xi.27 at Great Pond, Eastham, Cape Cod, Mass., U.S.A.
15. Shot 27 xi.29 at Toomebridge, Co. Antrim, N. Ireland.
16. Shot 29 xi.29 at Colston Lake, Cambridge, Maryland, U S.A

17. Shot 1 xii. 26 at Hawk Point, Cape Sable Island, Nova Scotia.
18. Shot 6 xii 28 at Keiss, Caithness, Scotland.
19 Shot 14.xii 28 on Lough Foyle, Ireland
20. Shot *23 xii 28* at Ravenna, Italy.
21. Shot 24 xii.26 on Loch Tarbert, Argyllshire, Scotland.
22. Shot 25.xii 28 at Laitburn, Invergordon, Ross & Cromarty, Scotland.
23 Shot *27 i 29* on Lady's Island Lake, Co. Wexford, Ireland.
24. Shot *1.ii.30* at Kirkwall, Orkney, Scotland.
25 Shot 15 ii.29 at Fleetwood, Lancashire, England.
26 Shot *8 iii.29* at Rugby, Warwickshire, England.
27. Shot 12.vii 28 at Bogorodizk, Tula, Russia.

[Bird-marking data provide no more conspicuous example of the value of the method than this series of recoveries, shown on the sketch-map in Fig. 1. It proves what has long been suspected that native Iceland birds may migrate habitually down both coasts of the Atlantic, a fact perhaps not irrelevant to the absence of geographical races among various species of holarctic duck. The fanning-out of birds from one small native area over nearly 30° of latitude and 110° of longitude is much the greatest recorded. It seems analagous to the double south-west and south-east migration of Central European White Storks *via* Spain or Asia Minor, but on an incomparably larger scale. The suggestion of a possible overland route to the Adriatic is also noteworthy. British native wigeon have covered some very long distances, but these data must place the species among the most remarkable migrants whose travels are at all accurately known.]

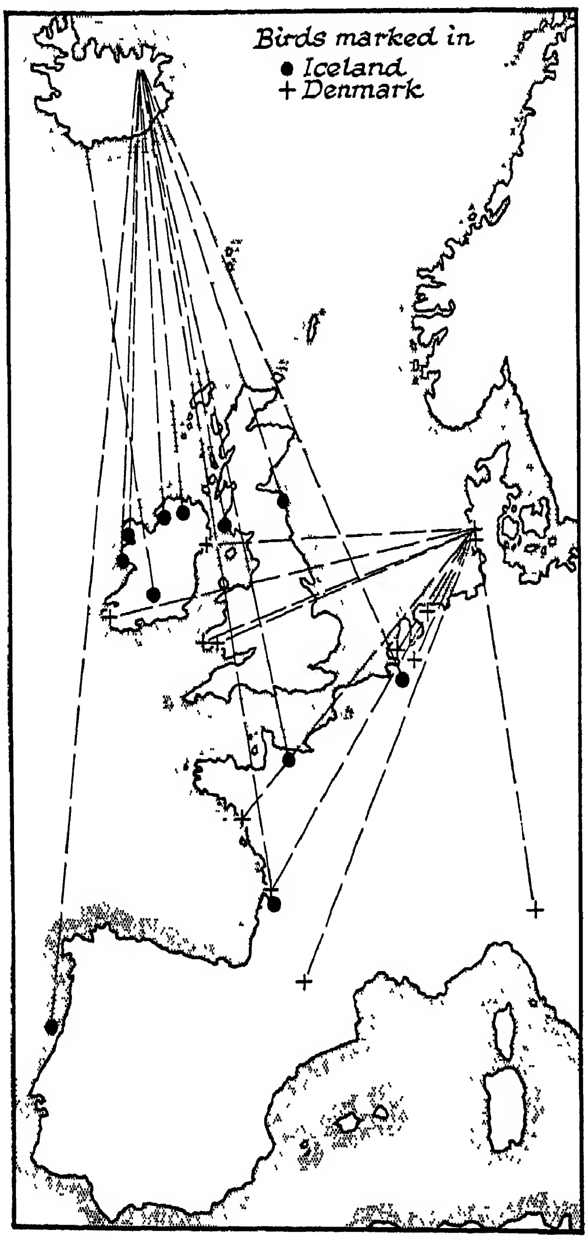


FIG. 2.
RECOVERIES OF TEAL.
This map shows recoveries of teal marked in Iceland and at Fanö (Denmark). The British Isles are here seen to be an area of concentration of birds native to two distinct areas.

Teal.

1. Shot 20 viii.28 at Lawrencetown, Co. Down, Ireland
2 Shot 25.x 27 at Varoville, Calvados, France
3 Shot 30.x.28 on Longfield Flats, L. Foyle, Co. Londonderry, Ireland
4 Shot 30 x.28 at Valado dos Frades, Portugal.
5 Shot *27 xi 29* at Cashel, Co. Tipperary, Ireland.
6 Taken by net 7 xii 27 at St. Ciers, Gironde, France.
7 Shot 10 xii 29 in Wigtownshire, S W Scotland.
8 Shot 14 xii.28 in Northumberland, England.
9 Shot 10 i 29 at Ballinasloe, Co. Galway, Ireland
10 Shot *20 ii 29* at Ballacroy, Co Mayo, Ireland.
11 Shot - iii.29 at Rethy, Antwerp, Belgium.

[While only 14 British ringed wigeon out of 122 marked have so far been recovered, the material for teal is much more substantial, amounting under the *British Birds* scheme to 88 records. Although many of these refer to birds marked as adults on passage as well as natives recovered in Norway, Sweden, Denmark, Finland, Germany, and Russia, the extensive traffic to Iceland had not been brought to light from this in estigation. The sketch-map (Fig. 2) showing some Danish records in addition to the Iceland ones could be amplified to the point of unintelligibility by adding all available British data. It does, however, show clearly the position occupied by the British Isles as a winter reservoir for breeding teal, not only of home-bred stock, but of native areas far to the north-east, *via* Denmark, and north-west, in Iceland. In contrast with the wigeon, which shows an enormous south-east and south-west spread from a compact summer centre, the teal appears to make a moderately broad north-east and north-west fan from limited winter quarters.]

Tufted duck.

1. Shot *11 viii.28* at Northwich, Cheshire, England.

Scaup-duck.

1. Caught 12 x 28 on Hoornsche Meer te Horn, Holland.
2 Shot *30.x.26* at Belfast, N. Ireland.

3. Shot 10.xi.28 at Duncormick, Co. Wexford, Ireland.
4. Shot 30.xi.28 at Kampen on Zuider Zee, Holland
5. Shot -.1.28 at Monbach, near Mainz on Rhine, Germany
6. Shot *23.i.29* at Belfast, Ireland.
7. Shot 3 ii.30 at Makkum, Friesland, Holland.
8. Found c. 15.ii 29 at Trewern, Newbridge, Cornwall, England
9. Shot 23 ii 29 at Tillysburn, Co Down, Ireland.
10. Shot *3.viii.29* on Nigg Bay, Killary, Ross & Cromarty, Scotland.

[Iceland is one of the more important breeding-areas of this northerly species, and these records suggest that it is from Iceland that large numbers of the scaup-duck wintering in the British Isles may come. Scaup appear freely on the eastern portion of the Mediterranean, and the three recoveries of Icelandic birds from the Rhine basin indicate the possibility of an overland route south-east across Central Europe, although no doubt Arctic Russia and Siberia supply the bulk of the wintering stock in the Levant-Caspian-Persian Gulf area.]

Long-tailed duck

1. Shot 27 v.29 at Christianshaab, Greenland.

[Christianshaab is on the west coast, on Disko Bay, comfortably north of the Arctic Circle, and of any point in Iceland. A bee-line from the place of marking would lead straight across the ice-cap; more likely the coast would have been followed by Cape Farewell. The date is noteworthy, for laying has begun in Greenland by 1st June: there is thus a suspicion of *abmigration* (or adoption of a fresh summer area distant from the native one) such as has been detected in various species of European duck.]

Common scoter.

1. Shot 24.x 27 at Ponta Delgada, St. Miguels, Azores.

[Previous records of European marked birds from the Azores include a British black-headed gull and a Dutch Spoonbill—see Landsborough Thomson, p. 231.]

Red-breasted merganser.

1. Shot *20.ii.30* at Lemmer, Friesland, Holland.

Northern Golden Plover

1. Shot 12.x.29 on Canal de Lucon, near La Rochelle, France
2. Found 21 x.27 at Tullarvan, Kilkenny, Ireland
3. Shot 22 x.27 at Ballinasloe, Co Leitrim (?), Ireland.
4. Shot - *x 29* in Ireland.
5. Shot 3.xi.26 at Bihoues, Coudarn, Gers, France.
6. Shot 4 xi.26 in Offaly, Ireland
7. Shot 1 xii 29 on Solway Sands, Wigtown, S W. Scotland.
8. Shot 15.xii.29 near Lisbon, Portugal.
9. Shot 26 xii.29 at Cloughmills, Co Antrim, Ireland.
10. Shot 6.i.30 at Hornby Castle, Lancaster, England.
11. Shot 6.i.30 at Hairpin Island, Garringaloe, Co. Cork, Ireland.
12. Shot 30.i.28 on Spanish Island, Baltimore, Co Cork, Ireland.
13. Shot 1 ii.28 at Dooyork, Geesala, Ballina, Co Mayo, Ireland.
14. Shot c. *3.ii 30* at King's Lynn, Norfolk, England

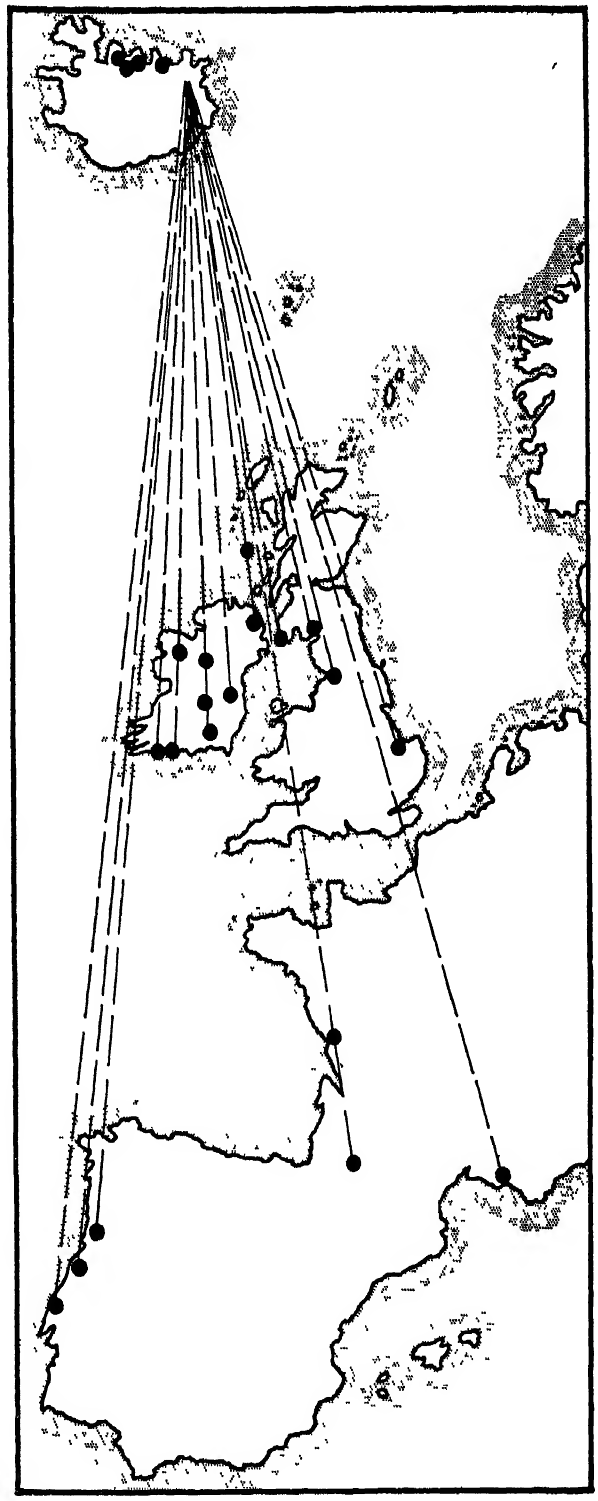


FIG. 3

RECOVERIES OF GOLDEN PLOVER

These birds were marked in Iceland and their narrow belt of distribution may be contrasted with the broad fan shown by the wigeon (Fig. 1).

15. Shot 16.ii 29 at Walada do Ribotejo, Portugal.
16. Shot (? date) at S Martinho do Porto, Leiria, Estremadura, Spain.
17. Taken 22.ii.30 at Moniaive, Dumfriesshire, Scotland.
18. Shot 17.iii.29 on L'Etang de Berre, Bouches-du-Rhone, France.
19. Shot 12 iv.29 on Tiree, Inner Hebrides, Scotland.

[Golden plover of various races are amongst the best-known long-distance migrants in the world, but comparatively little marking work has hitherto been done on them: in this country, in fact, it has taken twenty years to mark 108 birds. The encouraging series of records here provided shows a curiously narrow north-and-south path, and raises the same problem as the Scottish Lapwing results; whether the birds wintering in Spain and Portu l get there *via* Ireland and the Bay of Biscay, or whether Ireland is simply an alternative destination, the rest travelling through England and by the west coast of France?]

Whimbrel.

1. Shot 11 ix.27 at Rochefort-sur-mer, Charente Inf, France.
2. Shot 21.x.28 at Dakar, Senegal, W. Africa.

[Whimbrel being for the most part passage migrants through the British Isles, cannot be marked by us on a satisfactory scale. Although no Iceland marked birds are yet recorded, there can be little doubt that this country lies on their normal route.]

Faroe Snipe.

1. Shot c. 5 xi.29 at Claremorris, Co. Mayo, Ireland
2. Shot - ii 30 at Ballina, Co. Mayo, Ireland.

[The distinct geographical race of snipe inhabiting Iceland and the Faroes was only finally accepted in 1923, and similarities of northern Scottish specimens have hindered recognition in some cases. This conclusive evidence of the presumed migration has therefore a certain value to students of geographical variation. Scottish marked snipe also migrate to some extent in winter to western Ireland.]

Greater Black-backed gull.

1. Found 3.i 29 on North Uist, Hebrides, Scotland.

[The sketch-maps show recovery localities outside Iceland. It should be understood that lines connecting the places of marking and recovery are inserted purely for convenience, and are not to be taken as representing the route by which the journey was made.]

* * * * *

To Mr. Nicholson's article I should like to add some remarks. The area now reporting birds is greater than that shown on his sketch-map (April, p. 119). I can add the rest of the African west coast, Greenland, and Iceland. The separate stations are collaborating as much as possible in order to search out birds reported which may have been overlooked by the station of origin. I wonder that the following ringing stations are overlooked by the author: Stockholm, Tartu, Riga, Brussels—further the stations which Roumania and Spain are preparing.

I fear that there will be many difficulties over collaborating under unified direction, and laying down the law regarding ringing in the separate countries will, I fear, only make difficulties for the stations, and seems not to be needed.—P. Skovgaard.

[The sketch-map referred to was, of course, only intended to give a rough idea of the regions covered by bird-marking schemes: the additions which Mr. Skovgaard's personal experience enables him to make are nevertheless very satisfactory, as bridging the two chief gaps indicated. There are various other marking stations extant, in addition to those mentioned in the original article, or now added by Mr. Skovgaard, but exhaustiveness was not aimed at, my original list (on p. 117) being expressly restricted to stations working on a useful scale—*i.e.*, those with over 10,000 marked birds to their credit. Small stations, or those which do not publish their records, are of doubtful utility to ornithology, as the article sought to show. With reference to Mr. Skovgaard's claim that collaboration is already practised as far as possible, it must be agreed that there is much to be said for private freedom of action; nevertheless, the fact that the important work carried out in Iceland is now made available for the first time to British ornithologists, who have done much to secure these records under the impression that they were Danish birds, is the best proof of the urgent need for a real pooling of resources in bird-marking. I should like personally to thank Mr. Skovgaard for his very generous response to my appeal for a better understanding, and for the trouble he has taken to make these extraordinarily interesting data available for English readers.—E. M. Nicholson.]

Cruises to the Tropics.

Comparatively few parts of the world may still be described as "unexplored," and the only regions of this character easily accessible by ordinary travel routes are in South America. The most interesting to the naturalist is the Amazon River, which flows through the largest tropical forest in the world. At the eastern end of this belt of forest lies British Guiana, which has recently been brought to the notice of scientists by the work of the Oxford University Expedition. The port of call here for the Harrison Line steamers is Demerara, other calls on this route being made at Barbados, Grenada, and Trinidad. Two weeks after leaving London the voyager reaches Bridgetown, which presents a vivid first impression of the tropics. A combination of sea and river cruise is available on the Booth Line, whose steamer *Hildebrand* crosses the Atlantic before proceeding a thousand miles up the Amazon itself. Particulars are announced of special winter cruises.

Colour-Change in Crustacea.

By M. Stephenson, M.Sc.

Department of Zoology, University of Birmingham.

The mechanism of colour-change in shrimps, prawns, etc. was unknown until recently, and its discovery forms an interesting chapter in biological research. Visitors to the seaside can easily study these changes.

A NUMBER of Crustacea have the power of changing colour with relative quickness, but shrimps and prawns, well-known to naturalists and fishermen, show this capacity in as striking a way as any, and have been most studied in this respect. The most striking colour-change is shown by *Hippolyte varians*, a little creature less than an inch in length, found clinging to weeds in rock pools. Green, brown, and red forms are known, found amongst seaweeds the colour of which they resemble. If they are shaken from their own colour of weed and placed in an environment composed of various coloured weeds, they instantly seek shelter in the weed most like their own colour. But if, for instance, red *Hippolyte* are given green weed only, they will, after a lapse of some days, become bright green themselves. The change is so extensive that, in nature, young forms which have taken to a habitat of one colour probably keep to this throughout life.

Whatever colour the prawn may exhibit during the day, at nightfall that colour is withdrawn; the body becomes transparent and tinged with bright blue, giving the animal a most ethereal appearance. This diurnal rhythm is so strong that it will persist for days, even though the prawns are forced to remain in continuous light or continuous darkness.

The forms most commonly met with around our shores are the common shrimp, *Crangon vulgaris*, various species of *Leander* and *Palaemon* (*P. serratus* is the prawn of the market) and the little *Palaemonetes varians*, often found in estuaries. The change shown by these forms is less striking than in the case of *Hippolyte*, but quite well-marked. *Crangon* is exceptional in the possession of a dark brown (melanin) pigment which makes the creature in its dark condition appear almost black, in its light condition a pale mottled sandy colour. In the case of *Palaemon* and its kindred, the body is normally transparent, this fact being more or less emphasized according as the animal is in its dark or light phase. In the light phase it appears to be colourless; in the dark phase it is banded and looks rather more opaque.

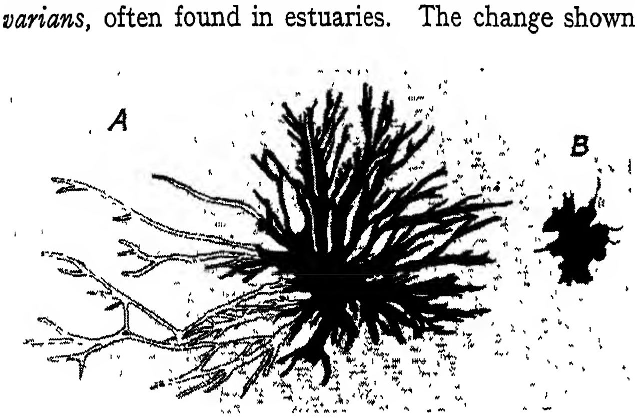


FIG I
EXPANDED AND CONTRACTED CHROMATOPHORE.
A, expanded; B, contracted chromatophore of *Palaemon* Red pigment is shown as black, yellow pigment as white

Response to Environment.

In nature, the light phase is assumed when the creature is on a pale background, such as sand or chalk; practically nothing is visible but the eyes, the general outline being lost. But animals taken from a district with dark rocks and weed will have a dark or mottled appearance and so will merge with the background. Either change puts the animal in harmony with its environment, and renders it inconspicuous, to our eyes at least.

This colour-change is made possible by the presence of chromatophores lying in the skin beneath the transparent shell. These vary in size, the largest being visible to the naked eye as individual dots. A chromatophore consists of a much-branched cell containing pigment and having one or more nuclei. A chromatophore may contain one or more pigments, and these may be present in solution or as granules, according to their chemical composition. The peculiarity of the chromatophore lies in the fact that the pigment may be aggregated at its centre, when it is barely visible, or may stream in a conspicuous manner through its branches. The aggregated condition is termed "contraction," its reverse "expansion," of the chromatophore. When the many hundreds of chromatophores present in the body expand or contract, the total effect is considerable.

The exact nature of this complex chromatophore is still a matter for discussion. Some regard it as an amoeboid cell, expanding and withdrawing its processes into spaces among the surrounding cells, and certainly young chromatophores are formed deep within the

body and migrate in amoeboid fashion to their adult position. But the very complex branching of the adult chromatophore makes this conception of its working a matter of difficulty. Recently consecutive photographs have been taken of the same chromatophore in expanded and contracted phases, and these show that the chromatophore each time it expands takes the same form in minutest detail. Walls of the branches when empty of pigment have also been described. It is almost certain, then, that the pigment moves to and fro in preformed channels. If the chromatophore is not in its nature an amoeboid cell, what is it? Possibly a much modified form of muscle cell, as has been shown by Spaeth to be the case for the chromatophores of fishes. The question must still, however, remain open, though facts recently collected point in that direction.

In the *Palaemon* type (Fig. 1), red and yellow light-transmitting pigments prevail, together with a small amount of an opaque, reflecting, pale-yellow pigment, which I shall refer to as "sulphur." At night, or on transference to a light background from a dark one, a bright blue pigment is formed around the red chromatophores. This permeates the tissues like a dye, and remains for about two hours, after which it gradually fades away.

A True Colour-Sense.

In *Crangon*, the prevalent pigments are melanin and sulphur, red and yellow being present in small quantities. In passing, it is of interest to note that Koller has recently shown that this shrimp possesses a true colour-sense. It can adapt itself not only to a white or black, but also to a red, yellow or orange background. How do we know that the animal does perceive red and yellow as colours, and not merely as different shades of grey, as is probably the case in many animals? To test this, specimens were placed in succession on backgrounds varying from white through twelve shades of grey to black, but the adaptations produced as a result were quite different to those produced in response to the red, orange, or yellow backgrounds.

When the animal is adapting itself to a new background, the different pigments do not move with the same rapidity, melanin and sulphur being more sensitive than red and yellow. Neither do they all move in the same manner. It is curious that in the *Palaemon* type, for instance, red and yellow will expand on a dark background, while sulphur will contract. On a light background the reverse takes place with the additional formation of the transitory blue. How long does it take a prawn to conform to a new background? The time and the completeness of the adaptation vary with the individual, but if one is watching the process the change becomes obvious in from three to five minutes, and will be outwardly complete within half an hour. Up to two hours is needed for the change to be perfect in every detail, and if the animal is trying to adapt itself to an abnormal background, such as red, several days may be needed, as was the case for *Hippolyte.*

Elaborate Mechanism.

By what mechanism does change of background stimulate the chromatophores to movement? The stimulus from the background is received solely through the *eyes*, direct light having no influence whatever. If one eye is covered or removed, the other is sufficient to allow normal adaptation to go on. But if both are put out of action no response is observed. The stimulus, then, is received by the eye. How is it carried to the chromatophores? It was naturally supposed that a nerve supply ran from the central nervous system to the chromatophores, by which route stimuli could pass directly from eye to chromatophores Several workers, from Pouchet (1876) onwards, tried to demonstrate that this was the case. The nerve supply to some area would be cut to see whether that area failed to undergo colour-change. But in no case, even by cutting the main nerve chain could the colour-change be affected! This seemed a remarkable state of affairs, the more so as it was already known that in fishes, cuttlefish, and certain reptiles, the chromatophores were directly under nervous control. Our knowledge remained in this condition until quite recently, when two independent workers, Koller (Germany) and Perkins (U.S.A.), began to reinvestigate the matter.

An alternative solution was suggested to Koller by a curious incident: of two yellow adapted *Crangons* living in the same vessel, one died and was partly eaten by the other during the night. The survivor was very much more yellow as the result. Clearly some substance making greater yellow adaptation possible had been taken in as food, had survived digestion, and had influenced the chromatophores. This at once suggested the presence of a hormone. With the exception of certain cells in the nerve cord of the leech which secrete a substance similar to, if not identical with, adrenalin, and occasional other obscure instances, hormones were thought to be present in Vertebrates only. (As is well known, a hormone is a chemical substance formed by an endocrine gland and passed into the blood stream, by which channel it reaches and affects structures distant from the gland.

Adrenalin, for instance, when liberated into the blood stream accelerates the heart beat and contracts the arterioles amongst other perceptable phenomena.)

Other experiments supported the idea that a hormone was present. If blood was withdrawn from a dark-adapted *Crangon* and injected into a white-adapted specimen, dark adaptation would quickly set in and would last for some time, passing off gradually as the foreign substance was eliminated. The reverse condition held good, showing clearly that the chromatophores were controlled by a substance circulating in the blood—one substance causing dark, the other light adaptation, the two apparently acting in antagonism.

Perkins showed the same fact by means of a neat experiment: he worked on *Palaemonetes*, a prawn in which the whole arterial supply to the abdomen flows along a single vessel As ligaturing this vessel proved too difficult, he made a V-shaped cut in the side of the shell, just beside the vessel This was then gently drawn out over the shell flap, being sufficiently constricted in this way as to prevent blood from flowing past the constriction. If a dark prawn with the abdomenal artery occluded in this way (at the front end of the abdomen) were placed on a white background, then the front part of the animal, by the formation of the white-adapted hormone, would become pale. The abdomen would, however, remain dark, since the hormone could not reach it by way of the blood stream. When the artery was released the hormone was carried to the abdomen, the chromatophores of which quickly responded.

The discovery that hormones were present in Crustacea was a striking one; they had been considered as the exclusive property of the Vertebrata.

It follows that it was necessary to discover the

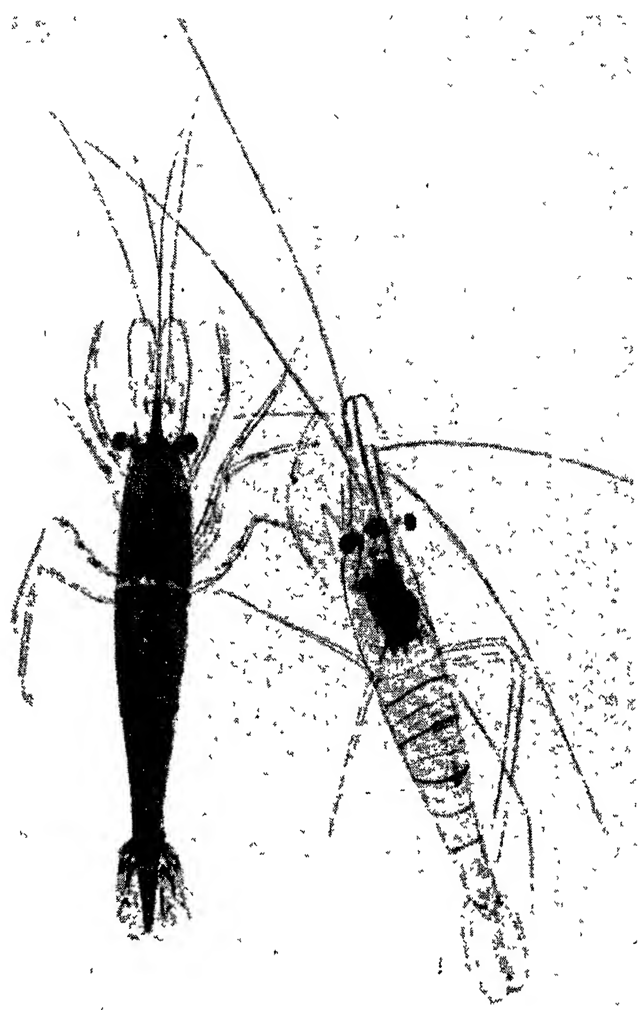


FIG 3
LIGHT AND DARK-ADAPTED PALAEMON
This remarkable photograph shows the same species of shrimp adapted on the one hand to a dark background, and on the other to light

position in the prawn of the endocrine glands responsible for manufacturing these hormones. Tissue from every part of the body was crushed in sea water and injected to see whether it would influence the chromatophores, but for a long time in vain. The query then arose, if the eye receives the stimulus is the hormone made immediately behind the eye, in its stalk? An extract made from eye-stalks was injected with startling results. *Complete light adaptation* took place in dark prawns, no effect being produced in light ones. The eye-stalks, then (Fig. 2), are the seat of the white-adapting hormone which will be referred to hereafter by Koller's term "contractin." The part of the stalk responsible for this is still unknown, for it contains little beside the optic nerve, but this "little" may be an instance of *multum in parvo*. A certain amount of contractin seems to be present in the stalk always, but its amount is greatly increased while white adaptation is in progress and while an animal remains on a white background. It would appear that a constant output of contractin

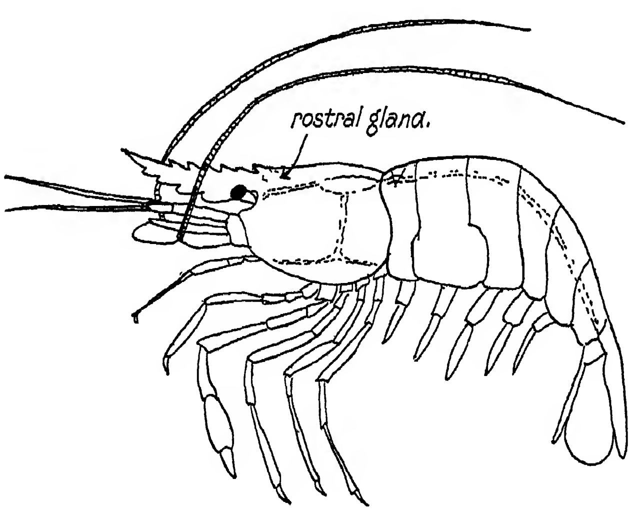


FIG 2
DIAGRAM OF A PRAWN.
This shows the position of the endocrine glands and occlusion of abdominal artery

is necessary to maintain the white condition, since if the stalked eyes are removed, expansion of all chromatophores quickly follows and white adaptation is impossible for the rest of the animal's life.

Many Problems.

Contractin, named by Koller, was discovered by Perkins, but he was unable to locate the gland giving rise to the second hormone. This was discovered by Koller, and is a small body in the rostral region, *i.e.*, it is located at the base of the spine which projects from the head. An extract made from this gland causes normal dark adaptation when injected into a light-adapted prawn. Koller terms this hormone *expantin*. If the gland which forms expantin is removed the animal becomes pale, and remains so indefinitely. So much is known, but the position is by no means simple. How is it, for instance, that contractin closes red and yellow while it expands the sulphur chromatophores? Again, is yet another hormone or pair of hormones responsible for yellow and red adaptation? What happens to one hormone when another comes into action?

The question arises as to whether crustacean hormones are similar in physical properties to those of the Vertebrata. Three general properties hold good for Vertebrate hormones—they are thermostable, they are unaltered by digestion and their action is not specific to the animal which produces them. Thyroxin from the sheep is active, for instance, in frog and in man as well. These same properties hold good for Crustacean hormones. Contractin from *Crangon*, for instance, is known to be effective in at least five other types of prawns, the extent of the reaction varying with the species, and both other properties are manifested. Experimental work so far goes to show that the hormones of Vertebrates have no action on colour-change in Crustacea, and *vice versa*.

When an important physiological activity of this nature is discovered in one group of animals, one begins to enquire into its presence in nearly-related groups, such as those containing lobsters and crabs. Strangely enough, contractin and expantin are strongly present in the shore crab, *Carcinus maenas*, as I discovered a short time ago; one does not on casual observation suspect this animal of exhibiting colour-change. The hormones of the crab are, moreover, very active when introduced into the prawn. The accompanying photograph (Fig. 3), shows a normal dark-adapted prawn and a similar prawn after injection with crab contractin.

The crab possesses these hormones, but they do not seem to exert such a strong influence on its chromatophores as in the cases we have already described, neither does movement of the chromatophores cause such an obvious change by reason of the thicker shell of the crab. If a number of shore crabs are looked at carefully, a fairly uniform pattern of dark and light areas can be observed on the back. This is caused partly by pigment in the shell itself, partly, as in prawns, by chromatophores in the underlying skin. These are to some extent visible, for the shell is actually translucent. The skin chromatophores are much like those of *Crangon*, but smaller and more densely grouped. Their movement is only visible in those areas not occupied by the shell pattern itself, this pattern being mainly dark. In a dark-adapted crab the movable areas are dark and the whole back consequently rather dark; in a light-adapted crab the movable areas are pale, so that the back shows contrasting dark and pale areas.

It is simple and interesting to witness these changes if one is at a part of the coast where shrimps and crabs are to be found. To furnish a light and dark background the animals should be placed in vessels with floor and walls of black and white. If the sea water be aerated frequently by means of a syringe the animals will live easily from morning until evening, giving enough time to watch the change in prawns at least. Those of crabs may be more difficult to demonstrate, but can be seen by careful observation.

More Research Wanted.

Colour-change is known to occur, then, in the prawn and crab types, and it has just been shown by an American worker that river crayfish also exhibit the same capacity. It would appear that the phenomenon is of widespread occurrence among the higher Crustacea, and it remains to discover in how many the capacity manifests itself and in how many, where not manifest, it is present in a latent condition.

In summarizing the position we see that in some animals the chromatophores are directly under nervous control; in others the nervous system stimulates endocrine glands to the secretion of hormones, which in turn control the chromatophores. An illuminating suggestion was recently put forward by an American professor—a suggestion which unifies the two conditions. In cases where nerves run directly to chromatophores, do they stimulate the latter by means by a secretion formed at the point of contact? Instances are now definitely known of secretory activity on the part of the nervous system itself, so that there is no reason against this suggestion. It is a matter which awaits proof but opens up a new field of enquiry of immense interest.

The Seismograph as an Explorer.

By R. E. Lancaster-Johnson.
Geological Survey, Mexico.

Among the latest applications of science to industry is the use of the seismograph as a means of locating oil. The author has been working with an oil company in Mexico, and gives a first-hand account of this method.

To most people the seismograph is merely known as a means of registering earthquakes. They regard it as an obscure instrument, standing in a laboratory and looked at occasionally by a professor of science who reports, for instance, that tremors felt in the South of England were traced to some internal volcanic eruption in Spain. Actually the seismograph has an interesting history. During the war, for instance, it was extensively used by the Germans to locate enemy artillery in registering the range by sound and earth vibrations as they fired. Its war service ended, the instrument became an explorer, and can now be found in Russia, Persia, Mongolia, Brazil and Mexico, in the constant service of oil and mining companies.

A New Venture.

It is not, in fact, generally recognized that the seismograph has recently acquired great industrial importance as a means of locating oil. The application of the instrument to industrial activities is, of course, quite a new venture. "Until recently," writes Mr. J. W. Williamson in his book "In a Persian Oil Field," "the science of seismology has been confined, for the most part, to recording and measuring the earth tremors caused by earthquakes and to deducing from the measurements the locations of the original disturbances. The seismic method of exploration is similar in principle to the other methods, in so far as it is based on the existence of a difference in certain physical characteristics between the rock-forming structure to be located and the structures above it which form the overburden. In this particular method, advantage is taken of the different velocities with which the earth-tremors—which to the physicist are elastic waves—are transmitted through rocks having different elastic properties and densities. For example, the velocities of compressional waves in sedimentary rocks are of the order of one and a quarter miles per second, whereas in igneous rocks they are from three and a third to five miles per second."

In El Zapotal, which comprises three native huts and two portable tent-houses, and situated near the village of Piedras Negras in the State of Veracruz, dwell seven Europeans and two American citizens. This little band of men is the seismos party (the only one in Mexico) of one of the leading oil companies in the country, and their business is to find the location of oil with the aid of the seismograph. The party consists of the party-manager, the engineer, the radioman, the dynamiter and five observers.

The "Shot-point."

Before a camp is pitched, the engineer is sent out to the locality in which the party will operate. Engaging fifty or sixty peons (labouring peasant Indians), he cuts a "brecha" ten to fourteen miles long through forest, scrub, and long grass. The pathway must be in a dead straight line, so that it often runs through sugar and banana plantations, mosquito-infested swamps, and clumps of shrubbery where tarantulas, scorpions, and such parasites as the garrapato and pinalia abound When the brecha has been cut, numbered stakes are placed in the cutting at calculated distances about six hundred metres apart, indicating the positions where "observing stations" will operate, and holes of nine feet deep and twelve inches in diameter are drilled for the "shot-point." On completion of the first brecha, the rest of the party arrive and the "shooting" begins on this cutting, while the engineer carries on with the second cutting, which generally runs through the centre and at right angles to number one. So he continues until the brechas run from the camp like the spokes of a wheel from the hub. He works from sunrise to sunset, and is often so far away from camp at night that he has to build a smoky fire around him so as not to be literally stung to death by the millions of mosquitoes that exist in the swamps.

It is of the actual operating of the instruments themselves, however, that I can speak with more authority, since I was both radio-shotpoint-man and observer in turn. Just before dawn two "camións" (light motor truck), loaded with instrument boxes and carrying some fifteen peons each, set out from El Zapotal. The observers and the radioman and their assistants, a company of twelve in all, follow the

motor trucks on horseback. A fork in the road is reached, and the "shot-point camión" turns to the left, followed by a European horseman and his Mexican "audante" (assistant), while the other car and the mounted men proceed down the straight. Soon the road which the trucks have taken become little more than a sheep track, and eventually the motors must make their way over rough ground, through tall grass, winding in and out of wood and copse. After a two hours' journey the edge of a swamp is reached, when the dynamite and radio instruments have to be carried round to the entrance of the brecha near the point at which the first shot will take place

Under the direction of the dynamiter, who has ridden in the truck, the explosive is carried (each peon packing one case of twenty-four pounds) to the "shooting point" where the sticks are taken out of the boxes, and the already drilled holes are filled. The dynamiter then "tamps" it down, inserts the fulmanite caps and attaches the shooting line, run out from the point at which the portable wireless transmitter and receiver has been erected to a point some seven hundred metres away. He then returns and takes up his position near the wireless instrument to wait until he receives the "all ready" sign from the radioman, before he finally connects up his line completely for "shot." While these shooting preparations are in progress the radioman has had his aerial poles erected, and his radio instrument set up and adjusted for work. The radioman then depresses a key which starts a powerful buzzer working, and the signal is picked up by observers. This allows them to adjust their seismograph, oscillograph and camera ready for the shot. For three minutes the radioman depresses his key, then he switches over and speaks into the microphone asking if any stations are ready for shot.

The other camión and riders, who left the trucks at the fork of the road, have had a similar, though less dangerous journey. They are not carrying dynamite, but only the instruments required for the recording of the shot, the small tents and batteries. The truck may sink axle deep in soft ground, and it requires the combined efforts of all the peons and the saddle horses to get it on to firm ground again, but they eventually arrive at an entrance into the brecha approximately midway between the points at which they have to operate. The truck is unloaded, and the instruments in their trunk-like boxes are carried to their respective stations Meanwhile the observer, who in all probability will be the last man to be ready for shot, rides slowly down the brecha, followed by his quadrilla (section of five or six men) with the apparatus on their backs, each man carrying something like eighty to one hundred and ten pounds. Eventually, he comes to a rough hewn stake stuck in the middle of the cutting, and on this stake is a number corresponding with the number given to him in camp as being the point at which he will take his first "shot."

EL ZAPOTAL

The camp of the Seismos party comprised three native huts and two portable tent-houses. The author occupied the circular hut in the centre, which was made of grass.

There the men begin to erect a station. The red-lined tent is set up, and along one wall is placed the compact wireless transmitter and receiver with its heavy high-tension batteries and large twelve volt accumulator, the latter being used for the camera light as well as for the wireless set. At the back of the tent the observer carefully places the seismograph and oscillograph facing the tent door. Then the heavy clockwork camera is set up on its tripod, the lens facing the seismograph and oscillograph some three feet from these instruments. The tent door is now closed, and the observer is in darkness. He switches on the hooded spot-light which is part of, and just below, the lens of the camera, its beam encircling both heads of the two instruments opposite.

The portable seismograph is similar in appearance to a four-sided clock tower, and is about three feet in height. A steel casing contains two suspended cones so delicately balanced that even the tapping of the ground with one's finger near the instrument will oscillate the two small mirrors that are attached to them by means of a human hair at the top or point of the cone. One mirror oscillates to vertical vibrations in the earth and the other to horizontal vibrations.

The vertical mirror only is considered necessary in locating oil, and the other cone is clamped up, but can be used in case of emergency. At the head of the seismograph, and in front, is a circular window about two inches in diameter through which the two small vertical mirrors can be seen. At the back are two adjusting screws for each mirror, which operate them in a vertical or horizontal position. When the beam of light from the camera strikes these mirrors, a "spot," or reflection, is thrown towards the camera, and by the aid of the adjusting screws, these spots can be manoeuvred so as to shine directly into the camera.

The observer, sitting on one of the instrument boxes in front of his apparatus, manipulates these screws, until the spot is shining directly into the lens. This is a tedious piece of work for the beginner, as the mirrors are only about three-eighths by a quarter of an inch in size, and the spot, as can be well imagined, is very difficult to find. Once found, however, it is an easy matter to bring it into the lens After adjusting the seismograph spot, the observer turns his attention to the oscillograph directly by its side. The oscillograph is nothing more than a telephone receiver with a small vertical mirror (similar to those in the seismograph) attached to its diaphragm, and enclosed in a metal case mounted on an adjustable tripod. Two wires run from the oscillograph to the receiver of the radio set, so it can be readily understood that strong incoming signals actuating the diaphragm would in turn cause the mirror to oscillate. This instrument also has a small circular window in the casing through which the mirror can be seen. This mirror, like those of the seismograph, is focussed on to the lens of the camera by adjusting screws, and when both spots are "on," the observer calls for light, while he examines his camera to see if there is sufficient sensitized paper on the "roll," and whether the clockwork, which carries it behind the lens, is working smoothly. The smooth working of the camera is very important, for the seismograph is so sensitive that the slightest vibration near the camera will cause the mirrors to oscillate, and should the mirror be oscillating when the shot is fired, the shock vibrations or "kick" coming in from the explosion will be lost on the photographed record, rendering the record useless.

His spots set, and the radio and camera working well, the observer slips on head-phones, tunes in to the "control station," and soon hears the low hum of the powerful buzzer as the radioman at the shot-point sends out his testing signals. Signals are sent out every fifteen minutes, and are followed by a request for the observers to report when ready for shot. Tuning in the signals to maximum, the observer switches over to the oscillograph and looks into the lens of the camera to see the oscillograph spot spread out to a vibrating line of about one-half inch as the incoming signals actuate the diaphragm. This is satisfactory, and if the seismograph spot remains steady, it indicates no outside disturbance and only moves if the "observer" taps the ground with his

THREE VIEWS OF AN EXPLOSION IN PROGRESS.

These photographs of an actual "shot" were taken from a distance of about six hundred metres. Left to right they show (1) the start of the explosion; (2) its full height; (3) settling down after the "shot"

foot. After three minutes of testing the buzzer stops. The radioman asks if everyone is " O.K. and ready for shot." All stations are ready by now and give their O.K.'s in turn. The radioman gives the warning, and the dynamiter connects his line to the "shooting box" via the radio instrument, so that when he drives the plunger down to fire the charge, the buzzer circuit is broken and the signals are immediately cut off. When the line is fixed, the radioman depresses his key and commences to send a series of long dashes.

The Explosion.

As soon as the first long signal comes through, the observer calls to his audante for darkness, the tent is then closed, and the head man of the quadrilla sees to it that none of the waiting peons so much as moves for the next three minutes. In the stifling tent, where often dozens of mosquitoes have collected, the observer switches on the camera spot-light, changes over the incoming signals from head-phones to oscillograph, and peers into his lens to see the stationary spot of the seismograph and the vibrating line of the oscillograph. For two minutes the long signals come through to give the operator time to get fine adjustments of his spots. Then comes the third and last minute of the warning. This is followed by short signals for half a minute, silence for fifteen seconds, short signals again for five seconds, and then the radioman calls out to the dynamiter to stand by. The dynamiter pulls up the plunger of his " shoot box." For the last five seconds the radioman holds down his key so that one long continual buzzer signal is sent out. Then he instructs the dynamiter to shoot. The plunger is pressed and the buzzer signals are cut off by the action of the explosive cap connecting the radio. Seven hundred metres away trees and boulders are blown to a height of two hundred feet by the explosion of two hundred and eighty pounds of dynamite.

When the observer in his tent sees the oscillograph change from a steady vibrating to a spasmodic jerking for the second time, he knows it is only ten seconds from "shot." He immediately starts his camera and peers again into the lens. The jerking of the oscillograph "spot" breaks once more into a steady line and the observer now keeps dead still, even holding his breath for the last few seconds. Suddenly the oscillograph ceases to vibrate and becomes still; probably two or three seconds elapse before the seismograph "spot" "kicks" a few times and then remains steady. If the observer were to let his camera run a few seconds more, the seismos "spot" would oscillate again, this time more violently as the sound vibrations of the explosion struck the instrument. But the expert observer stops his camera before this takes place, as a record of the sound vibrations are not required.

Quickly switching off the "spot-light," he slips on the head-phones, takes out the portion of unrolled "film" from his camera, and develops and fixes it in the chemicals (already prepared beforehand by his audante). The record fixed, he calls for light, and his audante opens up the tent and produces water with which to wash the record. By the time the film is washed, the aerial poles are down, the tent rolled up, and half the instruments are packed. Ten minutes after the firing of the shot the station is packed up and the party is ready to move on for the next shot.

In flat country, and where conditions are favourable, four or five "shots" a day can be made. But in the rainy season sometimes only one "shot" can be obtained owing to the difficulty of transporting the instruments over the swampy district of the isthmus. In the "Norther" season, when strong winds blow, it is impossible to make a "shot"; for wind-blown trees and shrubs and the swaying canvas of the tent will cause disturbance in the seismograph and render a good record impossible. In spite of its sensitiveness to movement, however, the seismograph system has the advantage over others at present in existence that a considerably larger area is covered in a much shorter time.

The records obtained are sent to the head office, where a seismos calculator ascertains, from a study of the records and by calculation, the different stratas of the earth, and whether liquid is present in the particular area surveyed.

"Buchan Spells."

According to Dr. C. E. P. Brooks, no scientific value whatever attaches to the so-called "Buchan Spells" cited by the newspaper weather prophets. The late Dr. A. Buchan enumerated six cold and three warm spells which recurred about the same dates each year in Scotland in the 'sixties of the last century. To discover whether similar periods occurred in London, observations have been made at Kew for more than thirty years past. The results do not give the slightest support to the idea that there is any abiding tendency for any part of the year to be either cold or warm for the season. The famous "Buchan cold spells" are abnormally warm as often as they are abnormally cold.

A Medical View of Good and Evil.

By R. McNair Wilson.

Author of " The Beloved Physician."

On the basis of conversations with the late Sir James Mackenzie, the author gives for the first time the views of this distinguished physician on what is one of the oldest problems in the world. The " doctrine of reaction" has special interest as being based on so many years of practical experience.

At the time of his death, the late Sir James Mackenzie, whose early work has, by common consent, revolutionized the knowledge of heart disease, was engaged on a series of speculations which he was not able to carry further than their preliminary stage. These speculations aroused a great deal of controversy, when some inkling of their nature reached the ears of the medical profession, but the material of sustained argument and criticism was lacking. To-day Mackenzie's latest ideas are largely unknown, even to members of his own profession. The present author was privileged to enjoy many opportunities of hearing Mackenzie expound his views, and thus came to be possessed of a body of notes, for he kept a record of what he had heard, the interest of which is very great. A study of these has suggested that the great physician was in process of evolving what amounts to a new philosophy of medicine when death overtook him. It has suggested, further, that an account of these ideas might be of general interest.

But it is necessary to explain, at the outset, that the views expressed have undergone a prolonged period of evolution in the mind of the present writer. They are not, therefore, put forward as representing exactly what Mackenzie thought, but rather as representing an effect of Mackenzie's later thought, teaching, and experience. It may be that an important difference lies in this distinction. On the other hand, an implanted idea, while it may assume different shapes in different minds, is likely to develop along the same lines, more or less, in any mind since its vitality lies in itself.

The Nature of Life.

Mackenzie, in his last days, found himself face to face with the oldest problem in medicine, namely the nature of life itself. He had worked towards a point from which he obtained a glimpse of a country not hitherto explored by any of his comtemporaries or predecessors, and he used to call that country " reaction." The word is, of course, a commonplace of thought and discussion, but in Mackenzie's mouth it had a special and peculiar significance which can best be grasped by saying bluntly that he was asking himself *if all stimuli are lethal in their first effect on the living organism.*

Constant Struggle ?

In other words, are those agreeable forms of energy with which our lives are habitually surrounded, light and sound, deadly weapons, the blows of which we only succeed in parrying by the exercise of vital activity? Put in this way the question seems absurd enough, but, in fact, a large body of evidence exists in support of an affirmative answer. Everybody is well aware that a strong stimulus often causes death, for example, a loud sound, a blazing flash of light, or a blow. In each case a condition of shock is produced and what Mackenzie meant by reaction does not take place. It is not, however, absolutely necessary to a fatal issue that the stimulus should be strong, and this point must be emphasized. A whispered word may kill. So may a gleam of light in certain special circumstances. So again may the touch of a finger. For these trifling stimuli may be " associated " with memory images that are far from trifling and which at once augment the effect, for example, when a guilty man feels the policeman's hand on his shoulder.

Again, there are states of physical weakness in which to pull up the blind of the sick-room is to cause the patient to faint, in which any loud sound, or any sound at all, may produce collapse, in which the very weight of the bedclothes becomes an impossible burden.

The enfeebled patient, in Mackenzie's view, is a patient with a greatly reduced power of reaction, and therefore a patient incapable of resisting the slings and arrows of his environment. He lies at the mercy of the lethal stimuli which surround us all. The sunlight, music, the gentlest physical contacts, even these are so many deadly dangers. This conception led at once to the question : what is the power of reaction, and how is it manifested? A direct answer was soon seen to be impossible, as

is generally the case in medicine. For the power of reaction is not to be measured as a potentiality. Only when it is manifested can it be measured. *Until a living organism is stimulated it cannot react at all.* Though, therefore, stimuli are lethal in the sense that they kill if no reaction takes place, they are also essential to life since no reaction can occur in their absence, a lively paradox, which, as Mackenzie saw, underlies every phenomenon of life, whether physical, mental, or spiritual. That paradox, as he used to say, haunts the mind of the philosopher who is troubled to understand why a God of infinite power and goodness tolerates evil, and how, as is evident, temptation is necessary to the building of moral strength. "It is by taking blows that we grow in fitness; it is by resisting temptation that we grow in grace."

The body is supplied with an elaborate system of nerves whereby stimuli are transmitted to all its members. This system, consequently, ensures that the lethal influences of environment shall penetrate to each cell. Reaction, therefore, is in the cell itself. It is, again, in every organ because it is in every cell of every organ. The first effect of a strong stimulus or shock is to cause the heart to stand still; its last effect, if the heart is sound, is to cause increased vigour of beating. But the word "cause" must be used with full understanding of its meaning. The stimulus never, in fact, *causes* reaction; it merely challenges it. There may be no reaction; for the stimulus may kill. There may be a feeble and ineffective reaction, as for example when the stimulus brings about a partial collapse. There may be a powerful reaction, as when the athlete returns blow for blow and overwhelms his opponent.

But again, reaction will vary in the same person at different periods of the same day. It will tend to be most effective in the morning; least effective at night. It is an exhaustible power as well as a power capable of cultivation and restoration.

"Nerves."

Everyone knows that stimuli are of all sorts of degrees and kinds. There is bright light and dim light; there is loud sound and soft sound; there are severe and gentle contacts. But what is less clearly realized is that the same stimulus may be severe in one case and gentle in another. A pat on the uninjured skin is a gentle stimulus; the same pat, on a raw wound, is a stimulus of excessive severity. The possessor of a raw wound cannot endure ordinary stimuli on the raw area, not because his power of reaction is diminished, but because his power of receiving stimuli is enormously increased. It is only necessary to suppose a case in which all the special senses are unduly acute to have a picture of a person incapable of living in his world. That many such people exist is certain. They are the nervous wrecks whose disabilities are too often ascribed to such causes as "hysteria." In fact, they need careful examination at the hands of specially trained physicians.

Failure to React.

Again, a stimulus received on a normal area of the skin or by a normal organ of sight or hearing may be exaggerated, in its passage, by nerves which are unduly sensitive. This occurs in strychnine poisoning, when the lightest touch is so violent a stimulus that the whole body is thrown into a convulsion in attempting to react to it—the convulsion representing a supreme effort to respond. It occurs also in diseases which excite the nerves. Mackenzie saw in all these considerations evidence that many of the symptoms of disease are, in fact, signs of failure to react to stimuli. Further, he came to think that such failure arises much more often as a result of exaggeration of the stimulus than as a result of any change in the power of reaction itself. For example, most cases with symptoms apparently referable to the heart are, in fact, cases in which the stimuli reaching the heart have been exaggerated by passage over an irritable nervous system, or by reception upon special senses made excessively sensitive by injury, deformity, or disease. He himself cured a case of chronic dyspepsia by getting the victim to wear spectacles and so removing the irritation to the whole nervous system caused by an astigmatism. The dyspepsia was a sign of that general irration and the consequent failure to make responses to the calls of life. Stimuli being lethal, it follows that exaggeration of stimuli imposes a heavy additional burden on the responsive mechanism and so leads quickly to symptoms of failure of response.

It is here that the mental process impinges on the physical. Man's mind is so constituted that almost every stimulus discovers associations in memory images which are, in fact, stored up stimuli. Thus, a voice recalls its possessor and the memories connected with him and all these are at once added to the simple stimulus of sound, with, it may be, devastating effect. The mind, therefore, is well able to exert an effect similar to that exerted by a poison which irritates the nerves, by an injury to a sense organ (*e.g.*, a raw area of skin), or by an actual increase in the force of the stimulus itself. A shout is a violent stimulus; so is a whisper falling on an unduly sensitive ear

or on an excited brain, so, again, is a whisper which recalls some terrible experience. In each of these cases an excessive reaction is demanded, exhaustion follows, or the patient does not even react with enough vigour to prevent the lethal effect of the stimulus from being revealed in collapse, perhaps in death.

Mackenzie's interest was directed, therefore, towards the factors augumenting the strength of stimuli, rather than towards the responses to these stimuli. He began to study sensitization and desensitization (It is known, for example, that a dose of haematoporphoryn, a well-known drug, may render an animal so highly sensitive to light that exposure to sunlight will kill it.) Both of these processes may be purely physical or purely mental, or a combination of physical and mental. For example, we may sensitize nerves with strychnine or desensitize them with bromide; we may sensitize the mind with alarming or terrifying suggestions, or desensitize it with confidence and security, and we may combine the use of drugs with suitable encouragement. The effect will be either to augment or diminish the force of stimuli, and hence the degree of response to them.

Out of all this emerged a philosophy. Reference has already been made to the toleration of evil; Mackenzie, perhaps, would have preferred to speak of the necessity of evil as a means of evoking good. He saw, too, that the good so evoked became stored up in memory as a "desensitizer" of the moral nature towards the very evil which evoked it. A man who has resisted temptation has forged, in his resistance, a new weapon against its future assaults. He is less temptable. Again, there are unseen sources of courage and confidence which discount the strength of temptation, just as there are sources of weakness and fear which augment it. The spirit of man may thus achieve complete victory over those powers of evil which threaten it with death, and in that sense may overcome death.

Moral Power.

The physical power of reaction necessarily diminishes and ends; but the moral power of reaction is not thus limited. The threat of physical death, which can destroy *morale*, can also evoke its most excellent expression, so that martyr and patriot seem to transmute the very act of dying into the substance of immortality.

Paradox and mystery surround this remote end of Mackenzie's thought. But his vision loses nothing of its interest on that account. He saw the office of the physician from a point of view far removed from that of the mere student of disease.

Correspondence.

EMBRYOLOGY AND EVOLUTION.

To the Editor of DISCOVERY.

SIR,

In another review by Professor MacBride of this very same book of mine, "Embryology and Evolution" (*Discovery*, June), he showed that he had either read or understood so little of it that he charged me with making statements which I never had made and which were not in the book at all, and with omitting matters which were printed in my book in terms almost identical with those in which Professor MacBride deplored their absence These, and kindred matters, are set out in detail in the current number of the *Eugenics Review* (Vol. XXII, pp. 71-74) I am glad to see that on this occasion he has abandoned these charges, though he still maintains that my book is full of fallacies which "would require a long and elaborate essay to expose them in detail."

I would like to draw attention to what I consider to be a fundamental fallacy on the part of Professor MacBride. He says that he believes in the "doctrine" of Recapitulation because hermit crabs, when young, have straight tails, and because in general the young forms of aberrant members of a group of animals conform to a type By what logical right does Professor MacBride assume and assert that this common youthful type must represent an *adult* ancestral type? I defy him to prove it

Yours faithfully,

4, Holywell, Oxford G. R. DE BEER

"THE TRUTH ABOUT PERSPECTIVE?"

To the Editor of DISCOVERY.

SIR,

I do not doubt the correctness of Mr. Boxsius's explanation (June) of the results of my experiments as due to the knowledge of the actual dimensions of the seen objects. It is the explanation that I myself gave I disagree, however, with his consequent dismissal of the results as examples of "errors" in perception This use of the word "error" implies a false theory of perception. Mr. Boxsius seems to suppose that our perceptions ought to be in photographic perspective although, in fact, they are not No perception in itself can be called "erroneous or unsound." Such a judgment implies reference to a standard If we did perceive in mathematical perspective, such perception would be erroneous when judged by the standard of the physical shapes of objects. If we perceived them in their physical shapes, it would be erroneous when judged by the standard of mathematical perspective. Actually we perceive objects in a manner which is a compromise between these two ways. If we draw in mathematical perspective (and there may be better reasons for doing so than the trivial one that other ways of drawing appear to us to be "primitive or exotic"), then let us at least be clear as to what we are doing—we are not drawing things as we see them but in another (perhaps better) manner. Then we shall cease to talk about the "erroneous" perceptions of children, and appreciate more exactly the difficulties they have to overcome in learning to draw in the manner we require

Our perceptions may, and often do, mislead us as to the real properties of the objects we are looking at; they cannot

mislead us as to how we perceive. Let us suppose that I ask Mr. Boxius to match an ellipse with the apparent shape of a circular disc lying at such an angle that the short axis of its perspective figure is exactly one quarter of the length of the long axis. Let us suppose that he selects an ellipse of which the short axis is only one half of the length of the long one and says that this looks to him the same shape as the apparent shape of the figure he is looking at. Then, if he is answering truthfully, that is how he *perceives* the circle, not merely how he "thinks he perceives it."

A friend in Palestine very kindly sends me the following incident from *The Life of Sir William Quiller Orchardson* When painting his "Napoleon on board the Bellerophon," Orchardson had been persuaded to save himself trouble by getting a "perspective man" to draw in the boards of the ship. When the perspective man had done his work, Orchardson "went to his studio, looked at his picture, sent for the housemaid and demanded a scrubbing brush and a pail of water; with which he scrubbed out the day's work of the perspective man, then he drew the boards in himself easily and quickly He told me the boards appeared to be almost standing on end when drawn according to rule because the eye does not see correctly; and a picture to be correct—right—must represent what the eye can see." Thus, by practical experience, Sir William Orchardson discovered what can also be proved by laboratory experiment—that the laws of perception differ considerably from the laws of mathematical perspective.

Yours faithfully,

The University, ROBERT H THOULESS.
Glasgow.

To the Editor of DISCOVERY.

SIR,

In your June issue Mr. R. H Thouless uses the expression "the laws of psychological perspective" I hope he will be able to discover what these laws are, but it must not be assumed that every artist has a sort of instinctive knowledge of perspective, whether mathematical or psychological. Most painters of objects of which the perspective can be tested mathematically have had to make a careful study of the subject, and there are some quite eminent ones who have not mastered it, even among those who have specialized in architectural subjects Others, who have devoted themselves to subjects in which the perspective is not so easily called into question—landscape, for example—have given the matter far less serious attention, and their perspective is generally more or less logical guesswork, which produces satisfactory results unless the subjects present unusual difficulties.

No test with the human eye can obtain exactly the same results as those obtained with the imaginary mathematical eye which is focussed to a point with "no parts or magnitude." But Mr. Thouless's argument, as I understand it, is that the variations from the mathematical perspective which he has noted in pictures and in experiments are greater than one has any right to expect, even when full value is given to the human factor. This is certainly a matter for the psychologist. I believe that the ordinary untrained eye frequently sees things just as loosely as the ordinary untrained brain frequently conceives them. The average person will be satisfied that there are "half a dozen or so" chairs in a room; the mathematician wishes to know that there are precisely five, six or seven. The laws governing such variations can doubtless be formulated, but I feel sure that they cannot be justified as a *substitute* for mathematical laws, in painting or anything else.

Yours faithfully,

The Priory, C E HUGHES.
Orpington.

To the Editor of DISCOVERY.

SIR,

I have read with great interest Mr Thouless's article "The Truth about Perspective?" (April), and Mr. Hughes's comment in your May issue If you will allow me the space, I will advance arguments that go to prove, I think, that (1) Mr. Thouless's discovery is probably quite valid; that (2) the teaching of perspective drawing should nevertheless continue; while at the same time (3) Mr. Thouless's discovery has great value for both art critics and art teachers

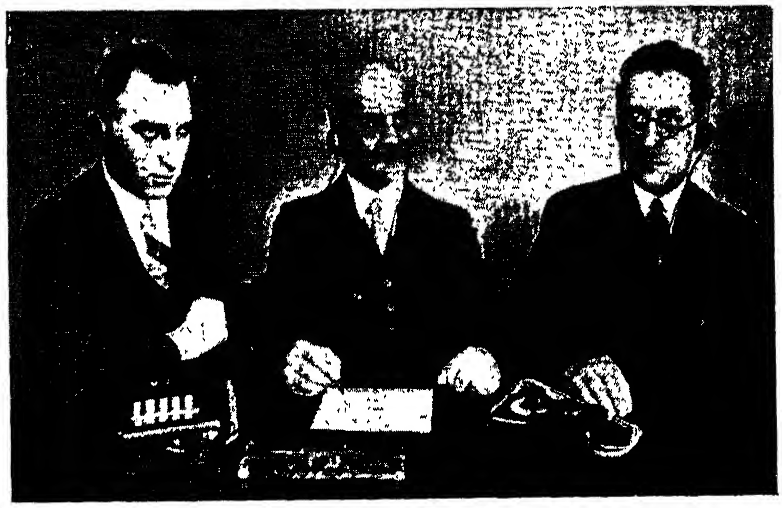
(1) The question of the validity of the discovery can be approached through a consideration of Mr Hughes's criticisms. Mr Hughes has very clearly demonstrated the variation between mathematical perspective, which assumes only one eye-point, and visual perspective, which is a product of vision from two eye-points. It is important to note, however, that the compromise between the two "eye-views" which we get in visual perspective, is a compromise between two views, each of which is in *mathematical perspective*; whereas the compromise which Mr Thouless says we make in seeing shapes is one between a perspective view and a purely mental conception of the real shape of the object being looked at. Mr. Hughes's criticism therefore fails to touch Mr Thouless's thesis.

It may appear strange to some that physical vision should be influenced by the mind to the extent suggested by Mr. Thouless; but conclusive evidence has been brought forward by modern psychology, and endorsed by teachers of philosophy, that our vision is at all times largely mental. It is believed that our vision of an orange, for example, would be vision merely of a confused round mass of dark and light yellow, were it not for our past innumerable experiences of touch and smell sensations, which by association with our visual sensations of shape and colour, enable us to interpret these last and see the orange in its actuality.

The final appeal in this matter, however, must be made to experience. My own drawing experience (a fairly lengthy one) was always that the ellipses presented by circular shapes appeared to my eye broader, or "fatter," than I found them to be by measuring with the pencil at arm's length. More convincing than any individual's testimony is the concentrated experience contained in Mr. Thouless's experiments. These, with his analysis of orthodox and "post-impressionist" pictures, are to my mind quite convincing, and accordingly I for one accept his findings as absolutely correct.

(2) The question now arises: "Should drawing in perspective continue to be taught and practised?" This cannot be answered until another question is first considered. "Is the effect of a drawing in perspective any more realistic than that of a drawing of 'seen' shapes?" If it is, then I take it almost for granted that perspective drawing ought to be maintained. The realistic representation on a flat surface of the third dimension is one of man's greatest achievements; it immeasurably widens the scope of art; and two-dimensional pattern-making by means of "seen" shapes, such as that practised by Matisse, has no proper claim to be more than a special form of art, unless it is capable of presenting to human beings as realistic effects as have been hitherto presented by

Lectures in Three Languages.



NEW SPEAKING APPARATUS IN USE AT THE WORLD POWER CONFERENCE

Photographs from Berlin showing new apparatus for giving lectures in three languages simultaneously, as described in *Discovery* last month On the left is the sound-proof mouthpiece used by the speaker, a similar apparatus being used by the two interpreters The right-hand picture shows members of the audience using headphones and switch-boxes by which they can listen-in to the particular language desired

perspective drawings. I speak of "realistic effects" presented to "human beings" advisedly, as I wish to make full allowance for the human tendency to become accustomed to conventions After doing so, however, I still believe that a realistic effect can only be produced by a perspective drawing or painting

Accordingly, I altogether part company from Mr Thouless when he speaks of "conventional perspective" instead of "real perspective" or simply "perspective"; and still more when he says that pictures of the "post-impressionist" school appear to us distorted only because we are so accustomed to pictures drawn in perspective. Perhaps we could get accustomed to "post-impressionist" pictures and come to derive aesthetic pleasure from them, but Mr. Thouless has advanced no satisfactory reason why we should ever expect to get the illusion of reality from them, even through custom. He says that photographic exaggeration of perspective effects in near objects passes unnoticed, but that is not my personal experience. To take a practical point, the mere presence of photographs with their (on the whole) strict perspective would prevent us from regarding anything but perspective drawing as realistic.

A more fundamental question is, "What is signified by the agreement of photographs with perspective drawings?" To my mind there is signified the inseparability of perspective representation and realistic effect. The one argument needed for this, and for the solution of the whole problem, is indicated by Mr. Thouless himself when he says: "If the illusion of distance is perfect in a picture, then the mind will make its own corrections on circular shapes just as it does in looking at a real circular object." The matter becomes clearer if that sentence is rewritten as follows: "If the perspective in a picture is strictly represented, then the mind gets a perfect illusion of distance by supplying its own correction of circular shapes just as it does in looking at a real circular object." It is surely legitimate to say this when we consider that the waking mind makes such corrections minute by minute and second by second in looking at real objects. And if this correction is already drawn in a picture (as in Fig 4 in Mr. Thouless's article, a modern etching), then it seems only natural that, the mind making its own correction through force of habit, distortion will result from the double correction. Accordingly it seems to me quite certain that realistic effects in pictures can be built up only on a basis of strict perspective drawing.

(3) In spite of what I have said above, I consider that Mr. Thouless's discovery is one of great value. It should clear the air of art criticism, for there will no longer be any wonderment (at least on the score of perspective) as to whether "post-impressionist" or orthodox artists draw the more correctly, or as to whether there is a standard of accuracy. That standard is supplied in the realm of perspective, by strict drawing, and the "post-impressionist" school can only claim that their's is a special form of art, or a new convention in it.

Still more valuable will be the effect of the discovery on the teaching of art, for the art teacher will be able to teach perspective drawing more sympathetically, and therefore with better results, than hitherto he has been able to do. This applies specially to the teacher of young children. Instead of arguing with the child that he sees things in perspective when he does not, the teacher will agree with the child in its visual interpretations. But having done so, he will lead the child to observe how much more realistic perspective drawings are than the child's own impressionistic drawings, and so convince him of the need for drawing in perspective. No doubt the subtle distincton will be beyond children of very tender years. But the precise stage at which the attempt is to be made of pointing it out is a matter to be determined by experts

Yours faithfully,

THOMAS M. Y. MANSON.

Lerwick, Shetland Islands.

(This correspondence is now closed—ED., *Discovery*.)

The Greatest Hoax of Modern Times.

By V. Gordon Childe, M.A., D.Litt.

Professor of Prehistoric Archaeology, University of Edinburgh.

Now that the case against the Glozel "discoveries" has been completely proved, it will naturally be asked why were so many experts deceived? Professor Childe answers this question, showing how it came about that an international commission had to be appointed before the greatest hoax of modern times was exposed.

ALLEGED discoveries at Glozel, near Vichy, a couple of years back received publicity rarely accorded to authentic archaeological finds. For all the fuss was over a fraud. The epitaph on the incident has just been written by M. Vayson de Pradenne, who first exposed the forgeries in France.* The time is thus opportune not only to signalize the laying of the ghost, but also to consider the lessons to be learned from its emergence.

Missing Facts.

In every science there are vast gaps in our knowledge and room for all sorts of startling discoveries to fill these gaps. But in the older sciences, such as astronomy and chemistry, an expert can to a large extent define the limits of the possible and reject *a priori* fictitious discoveries; there may be new planets in the solar system, but no astronomer will give credence to one reported between the Earth and Venus. But in archaeology it must seem, at least to the layman, that even experts can be taken in by the silliest hoax: for the Glozel "discoveries" were just as plausible. How does this come about? In the first place prehistory is divided into several widely separated compartments or disciplines: Pleistocene archaeology, Oriental prehistory, European archaeology, etc. This departmentalization is still seen in the dispersal of archaeological subjects in the Cambridge tripos. Moreover, the several departments have not arisen, like physical, inorganic and organic chemistry, from the subdivision of a single science, but have been reached from different extraneous disciplines; Pleistocene archaeology is rooted in geology; Oriental prehistory in Ancient History in the literary and philological sense.

It is really only since the war that substantial progress has been made towards unifying the results of the several distinct investigations into a comprehensive and coherent system. Such a system now exists in a rudimentary form. But some older archaeologists, trained in one of the special disciplines, do not yet always fully recognize its implications, and incline to regard the standards of their own branch as decisive for the whole. To the general public, on the other hand, such divisions (which really imply profound differences in method) are unknown; an archaeologist is an archaeologist whether his speciality is mediaeval architecture, Greek coins, or the fracture of flint by lower palaeolithic man. Moreover archaeology, like natural science a century ago, is still very largely a hobby for amateurs. The generation of systematically trained prehistorians is still comparatively young. The layman has come at length to recognize the necessity for a laborious training to produce astronomers and chemists, and the authority of those who possess such. He has not yet grasped the fact that a pastrycook or a shoemaker is not *ipso facto* more competent to decide intricate problems of prehistory than of astronomy, and expects museum-directors to master the huge literature of the subject in the intervals of classifying fossils and identifying Old Masters. Belated survivals of extreme departmentalism, refusing to acknowledge its limits, and the credulity of the public (including a large section of the intelligentsia), failing to recognize any unifying body of principles based on the conclusions of the subdivisions, alone allowed the Glozel "finds" to win more than momentary local acceptance. For in the light of modern prehistory they were patently absurd.

What was Found.

The objects alleged to have been dug up on the farm near Vichy included the following entirely irreconcilable types: pebbles engraved with bad attempts at a reindeer (an animal extinct in Central France at the beginning of Holocene times), and other scratchings in the style of Old Stone Age art; ground stone axe-heads of New Stone Age type; incredibly bad vases with eyes and nose in relief like some Bronze Age pots from Troy; and "tablets" bearing signs of the Iron Age alphabets of Phoenicia and Italy! The last named objects first aroused the interest of a local schoolmaster, and were subsequently sponsored

* An excellent translation by Mr. O G S. Crawford appears in the June number of *Antiquity*.

by a country doctor, Morlet. Given the backward position of prehistory as a science, both can be excused for failing to recognize the impossibility of such a collocation of periods. But to what experts should the objects be referred? Morlet found a very distinguished geologist, Déperet, whose opinion would have been useful had the " deposit " been of Pleistocene age. But the objects clearly could not fit in there, and were being attributed to the still obscure " Mesolithic " which replaces the quondam " hiatus " between Old and New Stone Ages, and here a geologist might easily go astray.

Then came Reinach, a very aged and very distinguished classic and art critic of the old school, whose strength had always been literary and aesthetic rather than scientific.* Last century, when Petrie's discoveries in predynastic Egypt were unappreciated and the prediluvian civilization of Mesopotamia (lately revealed at Ur) still undreamed of, Reinach had sought the origins of higher culture in Western Europe. His " *Mirage orientale* " was a wholesome corrective to the extravagances of Pan-Babylonists, but his arguments have long ago been condemned by the facts. (While, for instance, it was not impossible chronologically to see in the rude statue-menhirs (carved stones) of South France in late Neolithic times the ancestors of Greek statuary, that is plainly impossible for the splendid sculptures of Old Kingdom Egypt.) But in Glozel Reinach found support for his exploded theories, and his endorsement of the " discoveries " was not surprising. The sponsorship of two savants, both distinguished in entirely different disciplines and with no special knowledge of the quite recently defined Mesolithic age, backed up by a few folklorists, anatomists and philologists, was, of course, sufficient for the public whose attitude to prehistory I have characterized.

No Real Deposit.

An international commission had to be appointed by the *Institut d'anthropologie* to expose a fraud which should have been condemned *a priori*. The visit of the investigators to the site will be best remembered by the discourteous attack made by Morlet on Dorothy Garrod, the representative of Britain. The Commission exposed the absurdity of the whole affair. There was no real deposit, nor had there been any regular search for such. Now three thousand choice products of prehistoric handiwork cannot be collected from shallow trenches in a field unless there are very substantial fixed remains of human activity. At the time of writing I am digging an exceptionally prolific site in Orkney which has yielded a thousand or more relics. But we have six to ten feet of solid kitchen-midden full of shells, broken bones and ash, and the remains of ten huts within a couple of acres. At Glozel there were only traces of a glass-furnace (conveniently forgotten after the first years) and three alleged tombs that seemed to the commission spurious. The commission, moreover, found the small oblique holes whereby the objects had been introduced into the soil to be disinterred in the excavator's trenches, and other evidence of disturbance of the ground. Then a technical expert, Champion of Reinach's own museum, examined the " relics," revealing, for instance, the marks of metal tools used for drilling and grinding these products attributed to an early phase of the Stone Age! Champion's report closed the discreditable episode as far as international science was concerned. The failure of the first victims of the hoax to recant is perhaps not surprising, but only tarnishes the lustre of their services in other fields.

Who was Responsible?

The responsibility for the hoax is not yet fixed. Morlet's good faith has been generally admitted though his arrogance and perversity, all too typical of a certain type of selfish collector who insinuates himself into archaeology in France and other countries, did much to perpetuate the fraud. Vayson de Pradenne, who was the first to denounce the forgeries in France, has worked out a strong circumstantial case against the young Fradin, grandson and employé of the peasant owner of the farm. In his " Chronologie de Glozel " Vayson showed how the several classes of forgery (" inscribed bricks," " engravings," and eventually " pottery ") succeeded one another as models, in the shape of published drawings, were shown to young Fradin by his patrons, how the technique of the fakes steadily improved, and how the " finds " conveniently responded to every expressed wish of these patrons. And the digging was mainly done by Fradin himself with only occasional visits from the doctor, so that the peasant had ample opportunity to " salt " his field in the approved manner. But this is a matter for criminal law. The real lesson is the need for greater respect for the teachings of archaeology, and perhaps that its votaries should not be too bored or too polite to expose the absurdities of charlatans who still hang about the skirts of archaeology, though they do not happily in this country find such a credulous press as across the Channel.

* His style was well illustrated by his persuasive article entitled " Why I believe in Glozel," *Discovery*, January, 1928.

A Treasure Island of the Pacific.

By Bruce Bryan.

The theory that the desert island of San Nicolas was once inhabited by a hardy race of Californian Indians has now been proved by the archaeological discoveries of a recent expedition. It is also suggested that the Indians of the Stone Age were as keenly developed as the average twentieth-century human being.

It is difficult to trace the first record of San Nicolas Island; its existence was vaguely known long before it was ever mentioned in writing. Presumably it was first visited by a band of Indian warriors in search of the seafood which abounds about its shores. Were these Indians fleeing from the tide of the rising Pueblo races, or were they seeking a new home because of dissensions and rivalry in their own cultures on the California coast? Whatever the underlying cause, the fact remains that only a hardy, aggressive race could have built up a permanent abode on the volcanic segment known as the "Passing Isle," where a howling gale is almost eternally raging and heavy seas constantly thunder down upon its rocky coast.

For years San Nicolas Island has been deserted, occasionally visited only by fishermen, since nowhere in the world do better or larger quantities of deep sea fish abound. Pirates, smugglers, and rum-runners, too, haunt its vicinity, but they rarely land. It is feared because of the curious natural phenomena of the elements that seem to have marked it for their own, and through which it has acquired an evil name. Yet as a field for archaeological research it has proved to be a veritable storehouse.

Origin of the Inhabitants.

Numerous theories have been advanced from time to time as to the origin of the Indian tribes of California, and especially those of the outlying Channel Islands. Some ethnologists have regarded them as the descendants of those prehistoric people who once inhabited most of the south-west attributed to the Cliff Dwellers and Pueblos. They believe that the later house-building aborigines drove out these people and forced them to move on to California, where some of them took refuge along the coasts, while others ventured out to the islands and set up a culture of their own. Here they established trade with other islands and with the mainland, as shown by the many relics of their ancient commerce found to-day.

Supporting this theory is the fact that the California tribes are an older racial type than the Pueblos or Cliff Dwellers. Skulls of both the coast and island Indians reveal distinct dolichocephalic types, whereas those of the more advanced inhabitants of the south-west are clearly brachycephalic, or round-headed. Further, the Pueblos indulged in the custom of early applying a cradle-board to the heads of their infants, thereby causing them to grow to maturity with a peculiarly flattened cranium in the occipital. No traces of such artificial deformities have ever been found on either the coast or islands. But many articles of trade from both areas have often been unearthed, from soapstone images to pottery fragments and burnt shards. If there was ever a meeting point of the two opposing cultures, it probably was in northern Death Valley, where Pueblo shards of the most primitive black-on-white design and earliest coiled-ware are found in typical California Indian shell-mounds.

Valuable Finds.

An expedition organized by the Los Angeles Museum of History, Science and Art recently spent two months at San Nicolas Island, and returned with one of the largest and most complete collections of prehistoric Indian remains ever assembled on one trip. Among the material brought back and now on exhibition in the Museum are great stone mortars and carved pestles, bone- and shell-ornaments, beads of intricate and delicate carving, war-axes and clubs, abalone-shell fish-hooks, and a number of fine examples of small fish images carved out of soapstone and pearl shell. Four complete skeletons were found, together with a heterogeneous collection of human and animal bones.

Several hitherto unestablished facts were proved by this expedition, among others that the ancient Indian who dwelt in the most primitive of Stone Age environments on this barren island was evidently possessed of all the physical and mental characteristics of the average twentieth-century human being! And yet each of the four complete skeletons shows some indication of disease. The most interesting of these is a large one of a native who lived to be an old man, which was discovered to have a disease of the spine contorting it entirely out of

shape, and showing that this particular creature must have been a hunchback.

Completely encircled by dense beds of kelp through which small boats must thread a precarious path, San Nicolas is a desert place where nothing grows except a few straggling weed-clumps and cactus-beds and perhaps four inches of buckthorn grass on small stretches of the uplands. The sand is always blowing, in great dunes, from place to place, uncovering one graveyard only to conceal another. Enormous quantities of it are blown into the ocean, and on one day towards the close of the expedition's stay there, the combined forces of wind and rain had caused the north shore to present a muddied belt of water extending out through the breakers for half a mile. It is because the island is gradually being blown into the sea, that it is often referred to as the "Passing Isle."

Indian Life.

The expedition's first few days were spent in exploring the island and locating various sites in which to dig. Unlike most excavations, the order of approach here was different, since there were no strata by which to be guided. The method of procedure was sometimes to work together, and more often to work singly on separate sites, thereby carrying out three separate researches at one time.

A number of evidences of Indian dwelling places were found on the highlands, those above the west end seeming much older than the others, as shown by the hard nature of the soil and the scarcity of remains. But at times a great sand mound rises up, covered in the sun with a glittering shell-heap, where here and there a bone needle, an awl, some fish-hooks, exquisitely carved, or the top of a skull might be discovered exposed to the air.

Age of the Relics.

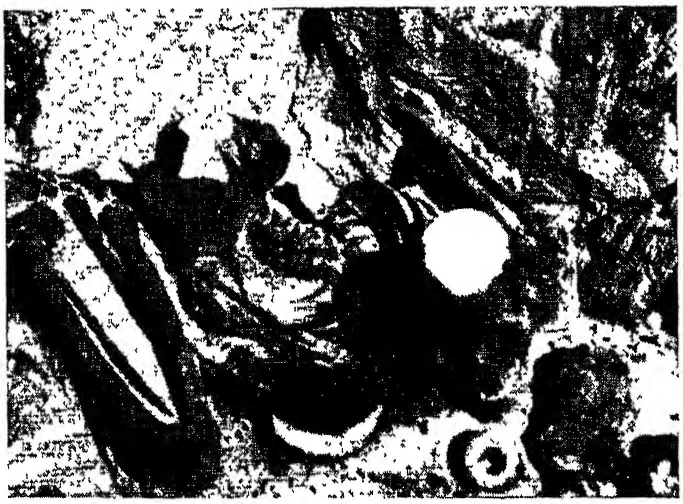
Arriving at the ages of the various relics found is a difficult question and can only be approximate. No trace of Spanish remains of the era of the *conquistadores* was uncovered, nor is there any record of one ever having put foot on the shores of San Nicolas, though they visited every other island of the Channel Group.

It is certain that all of the objects encountered on San Nicolas are at least one hundred years old, since the last natives were removed in 1830, with the exception of the so-called "Lost Woman," who was marooned there for twenty years and was taken off in 1850; she could not have left many relics by herself. Nevertheless, the nature of the soil goes a long way in aiding the archaeologist to determine the approximate period at which a particularly hard formation of sandstone, which must be hacked into with the aid of a pick and which yields up a skeleton or parts of one, was soft, loose sand as on the mounds. Again, it is a matter of osteology to arrive at the age of a handful of human teeth found in a somewhat similar formation, and which are so decayed

THE COMPLETE COLLECTION.
The Los Angeles Expedition returned from San Nicolas with one of the largest collections of prehistoric remains ever assembled on one trip

that holes are worn through the hard, bright enamel. In each case, similar finds were removed from each other by a distance of five miles in a straight line.

Near a sample of such teeth as these, we unearthed the body of what must once have been a great chief. It was situated in a grave on the west end, buried in the conventional flexed posture, and had to be cut out of sandstone of rocklike tenacity. Between the hands of this skeleton, which lay on its face, was a large white spear-head. The rest of the day was spent in carefully sifting out of the sand hundreds of small, square abalone-shell beads and the larger pendants, from the quantity of which he must have had a coat sewn. Curiously, three other skeletons lay close to this one, all in a direct line, the head of each pointing towards the west Only two skulls were brought in, however, including the first and that of a woman who had been interred with only a necklace of large reddish beads.



THE FIRST SKELETON DISCOVERED.
A number of stone accoutrements were found with these remains, which were disinterred on the west central plateau of the island.

Merely skimming the tops of those mounds that appeared to be less productive than others brought to light an almost unbelievable quantity of material. The amount of castaway shells and bones gleaming on the surface was also enormous. By crossing one of these great middens on hands and knees and using the eyes even casually many little shell fish-hooks, bone awls, harpoons, needles and the like were picked up. Sometimes on top of the mounds and sometimes on the sides were found bowls of stone and soapstone. Often these were revealed by a faint showing of the rim, to which they were buried in the sand. The larger mortars had to be dragged for miles on crude wooden sleds over the sands.

Great numbers of the relics found, especially the stoneware, were completely smashed. This work of demolition was undoubtedly carried out by the Indians themselves, and in a most businesslike manner. The queer religious beliefs of the ancient American Indians, often encountered among other aboriginal tribes in various parts of the world, may account for this wholesale destruction of personal utensils and household ware. It was thought by the old Indians that any implement a man manufactured was like himself possessed of a soul, or spirit. Therefore, when he died his bowls and other artifacts were broken and buried with him, or close to him. In this way were they "killed," so that their spirits might serve him in the next world!

Several different methods of effecting this breaking seem to have been practiced on San Nicolas. For instance, many of the bowls on the plateau were discovered with the bottoms alone smashed out. On the mounds toward the west end they were literally broken into the smallest of fragments. Others merely had a hole chopped into them. And in order to save themselves the labour of making new ones, later Indians utilized them by filling the holes with asphaltum, a tarry substance washed up on the rocks by the sea. One of the mortars brought in by the expedition shows a serrated line of chips around its rim, indicating the method by which they were sometimes demolished in a professional way.

At times a series of fragments were unearthed that would fit together perfectly to form a complete bowl. These were gathered up, the fragments numbered, and brought back for restoration at the Museum. But the old inhabitants of San Nicolas apparently foresaw that something like this would happen even to their broken utensils. Craftily they worked out a plan to prevent it. The archaeologist might find a broken mortar of ten pieces, nine of which went into place perfectly. The tenth would be a fragment of another bowl! And the missing piece was never found, which suggests that it was probably either ground into dust or thrown into the ocean.

For the first week or longer, everything come upon by the expedition had either been found before by some previous explorer or else was hopelessly scattered by sand and wind. Experience quickly demonstrated the futility of digging haphazardly. To turn up anything at all, surface indications must first be revealed. Otherwise one might dig on for ever. In addition, it was decided that it would be wise to construct several large screens to sift every inch of sand about a burial. This was a precaution taken

to save a skeleton down to the minutest beads and the smaller finger and toe bones.

The first complete and untouched grave was found on the west central plateau; the top of a bleached skull protruding above the sand led to its discovery. When dug out and developed the skeleton was found to be lying half on its side in a flexed position. The head was quite upright, having slipped with the shifting of the earth. The skeleton was that of a young man with a pronounced Mongolian cast of skull. A curious ossification had joined the pelvis together in one piece so that it resembled nothing so much as a saddle. Buried with it were a stone axe, two throwing-stones shaped like doughnuts, and a dish made of abalone-shell with the perforations plugged with the usual asphaltum.

THE HUNCHBACK SKELETON
Each of the four complete remains was found to be diseased. The most interesting, archaeologically, was a hunchback.

On the west end of the island there is a great continuous mound, stretching out for perhaps a mile and sloping down into the sea. Its entire expanse is covered with the remains of Indian feasts, and in its interior are hidden their bones Here protruding hip-bones revealed a grave that yielded one of the most unusual finds made on the island. The skeleton was the largest encountered, and upon closer inspection was seen to have a twisted spinal column, five of the vertebrae and the sacrum itself being ossified or grown together. A protective sheath of bone had extended over three of the vertebrae, partially joining a fourth. The skull was extremely large, as is generally the case with hunchbacks, while the sutures were grown together, indicating that he was an old man at the time of his death. The teeth showed considerable wear.

It is a noteworthy fact that of the many anatomists and medical men who examined this skeleton after it was brought back to the Museum, none have agreed upon what the affliction is, or even what caused it. Some were inclined to the theory that the aborigine had suffered a blow which broke his back, but that he lived through it, as shown by the subsequent overgrowth of protective bone. One physician claimed that it was a not unusual disease, and that it was not serious; in fact, he believed he suffered from somewhat the same thing himself. Finally, Dr. Roy L. Moodie, Professor of Anatomy in the University of Illinois, after carefully examining the skeleton, diagnosed the affliction as being tubercular.

Almost every conceivable question and angle in anatomy came up in the inspection of the bodies unearthed on San Nicolas. The only available way of distinguishing the sexes was from the shape and size of the various bones, the width and angle of the pelvis, the notch of the jaw, and the shape of the cranium. But it seems to have been a rule with the islanders to bury their squaws with a total lack of funeral equipment, though all the bodies were interred in some form of the conventional crouched or flexed posture, the knees drawn up under the chin and the arms clasped about them. One of the female skeletons was the only one which did not appears to have some affliction of the bones.

Two of the most unusual finds are the so-called "Cannibal Hole" and the "Artist's Mound." One member of the expedition discovered a deep grave on the north shore, near Coral Harbour. Because of the unexplained nature of its contents, this was rather facetiously termed the "Cannibal Hole" Passing through a layer of about one and a half feet of white sand, one and a half feet of black burnt midden, and two feet of a dirty brown sandy formation, he came to a red sand covering four *scapulae*, or shoulder bones of a whale, almost always a sure sign of Indian burial.

These were laid close together, and beneath them was a somewhat confused mass. Five skulls were set upright in a semi-circle, with three others on top of them. Discs of whalebone were placed against the faces of some, and under the jaws of three were found steatite pipes with incised designs. On the top of each skull was an abalone-shell dish, plugged with asphaltum. One skull had its mouth open, a shell-dish thrust between its teeth. At the side was a number of incomplete skeletons, laid out supine. In the centre, with the skulls, were a soapstone bowl, dish, shell-cups, bone implements of all varieties, a harpoon, several little images, and other parts of skeletons.

A child's skeleton was found here with the ribs arranged in a compact, unnatural position, many of the bones being missing. An adult skull lay in the centre of the mass, filled with small animal bones and human finger and toe bones.

Oddly enough, six bones were discovered that were subsequently identified in the Museum as the heel bones of deer. There were never any deer on San Nicolas Island, and furthermore these were the only parts of any deer found. The suggestion that possibly several haunches of venison had been brought over in an Indian canoe from the mainland is untenable. Doubtless they had some ceremonial significance, although it is well known that too often inexplicable phenomena are relegated to this class. At the bottom of this grave the skull and portions of a badly decayed, apparently much more ancient skeleton, were found.

THE CANNIBAL HOLE.

Four shoulder bones of whales covered the contents of this grave, found near Coral Harbour

This was a most bewildering burial place, and its arrangement is difficult to account for. Perhaps it was only an old Indian re-burial. That is, it is possible that later islanders found the skeletal remains of previous ones and religiously gathered together the most important parts and buried them again. It may be that these later Indians put their own artifacts into the grave with the older ones, and probably they also reasoned that since it was apparently the wind which had uncovered these old bones, they would this time fool the wind by digging a deeper hole.

The material removed from this grave is now on exhibition in one of the cases in the Indian Room of the Los Angeles Museum. In this case there is also displayed the small image of a shark, carved in the round, which was found lying on a sand dune raised over the "Cannibal Hole" by a later storm. This shark was perhaps once traded to one of the natives who lived on the dune by the old artist whose studio is to be found on the midden known as the "Artist's Mound." This mound is located about a mile west of the first skeleton discovered, and leads up to a long slope overlooking the middens and sea on the western end of the island. The reason for its name is apparent from a study of the material found there, and from the fact that it is the only place on San Nicolas where traces of ancient incised art were found in any quantities.

First remarked because of the enormous numbers of broken fragments of mortars and pestles strewn over its surface, it was later made a special point of investigation when Mr. Hatton found a number of pieces that fitted together to make a complete soapstone bowl. Here there were all kinds of evidences of former expeditions, but the previous scientists did not seem to put much value in the broken material that lay about. They seem to have torn into the site in a reckless sort of way, flinging things they deemed worthless in every direction. It is on this mound that Mr. Ralph Glidden, curator of the museum on Catalina Island, is said to have excavated a wooden coffin containing the skeleton of a dog.

Excavating the "Artist's Mound" was a matter of sifting every foot. Here were found three fragments of a large stone hook-shaped implement, measuring some sixteen inches in length, and unlike anything ever seen before. The top piece was never found. There were also parts of a shield-shaped slab, very flat and nicely ground, with bevelled edges, which has since been completely restored. Its use, along with that of the hook, is too remote even to conjecture.

The first image portraying some form of life was found in one of the graves on the "Artist's Mound," in the form of two halves of a broken soapstone shark with sail-like fin. Other articles included half of a small whale image, the head of another shark, polishing tools, arrow straighteners, abalone knives, fish-hooks, beads, pendants, and numerous other trinkets the use of which can only vaguely be surmized. One of the most valuable finds here was a collection of the original fabric, woven of reeds and grass by the ancient islanders, that had been preserved by a coating of asphaltum and the extreme dryness of the desert sands. Although this mound was excavated with great care, it will doubtless still yield much in the future to some enthusiastic ethnologist.

Book Reviews.

Beyond Physics, or The Idealisation of Mechanism. By SIR OLIVER LODGE. (Allen & Unwin. 5*s*).

This would appear to be an attempt by that virile and learned physicist, Sir Oliver Lodge, to show that certain puzzling relationships—to wit, matter, life, mind, and the survival of personality—may possibly be connected through a third intermediary which is the same as that which underlies, or rather is thought by some people to underlie, the modern physical theories of energy and wave mechanics. It is a little difficult to understand for whom the book was designed. It cannot be primarily for physicists, because although the major portion of the work is devoted to a recital, albeit an able recital, of modern physical theory, yet this is a subject with which the professional physicist is thoroughly conversant. On the other hand, it is far too advanced and technical in this respect for the average amateur. Another alternative is that it is intended to show the physicist that psychic phenomena may lend themselves to investigation by conventional physical methods. There is a suggestion of this purpose in several places.

The author seems to be opposed to the idea that the science of physics should confine itself to metrical phenomena, and apparently would prefer that the physicist should take upon himself the spirit of adventure and go forth to test his weapons upon strange media. Sir Oliver believes that "the ether is utilized and impregnated with something that may be called Life and Mind *in excelsis*, that it is the home of the ideal and the supernal . . . the vehicle or Concomitant of Supreme Mind" (page 47). Further, he says, "I feel as if I knew that portions of the ether are, so to speak, individualized . . . taking on here and there identity or individual form." Again, "My own conclusion based upon elementary facts is that Personality—when it exists—including Character and Memory, is certainly a persistent reality."

The book puts the physicist into something of a dilemma. He is accustomed to performing operations which have the nature of measurement. Certain groups of probabilities he deals with in statistical fashion, and calls them laws. When he deals with radiation and energy the most he will say is that these things behave as though they had their being in some queer medium. Some people, like Sir Oliver Lodge, call this the ether. As a matter of fact it was invented by a scientist as an assumption upon which to base a most valuable and workable scientific theory. All the phenomena, however, which the physicist relates to this assumptive essence, exhibit an extraordinary uniformity in their statistical manifestations. In other words, the laws which have been formulated as a result of their behaviour, have almost a universal validity. Surely it is asking the physicist to go a long way beyond his *venue* when it is implied that he should endeavour to measure diverse subjective phenomena on the poetical (not necessarily untrue) assumption that they have their being in the same hypothetical essence, which is so convenient as a background for the measurement of visible light and other ubiquitous experiences.

Ever since the time of the great Newton, physical science, by experiment and theory, has revealed more and more the wondrous order and beauty of the universe. Science will still advance and objective experience will extend; but, nevertheless, there is that inner consciousness of reality in man, that apprehension of God with its insistent urge to worship which seems to raise up an insuperable barrier between the spiritual and the physical. The mystical or spiritual side of man, appreciable as it is through the mind and unquestionably allied to it, seems to be of an entirely different nature to metrical things and by no means amenable to the same process of investigation.

Those of us who study physics in this generation have much for which to thank Sir Oliver Lodge. He is a great physicist and a great teacher of physics, and therefore it is difficult to assess correctly the purpose of this book. The author remarks on page 144 that his suggestion is "presumptuous and hypothetical"—even if this is so, it still remains that his great name commands the respectful attention of a large public. The book will probably have a large sale.

V. E. PULLIN.

Human Speech. By SIR RICHARD PAGET, Bart. (Kegan Paul 25*s*.).

The first six chapters (126 pages) are the best part of this book and the most truly representative of the author. If we add the thirty-six pages of Chapters XI and XII, what the book gives us of value is a personal study of practical vocal acoustics with applications to the imitation of vocal sounds by mechanical devices. Sir Richard's conclusions are based on experiments with models and with his own vocal apparatus, his ear in most cases being the *experimentorum arbiter*. In the early announcements the title given was "The Human Voice"—a much better name for the book, as the subject matter is mainly acoustic. The double resonator theory of vowel sounds is dealt with mathematically by Mr Benton in one of the eight appendices. But vocal acoustics, as Sir Richard himself points out, are not phonetics or linguistics.

The author, however, attempts to forge a link between his practical acoustics and what we may call his linguistics. The conclusion of his experiments is "that we unconsciously recognize the tongue and lip posture by their acoustic effects, and are primarily interested in the postures rather than in the wave form or tone colour which they produce." Few readers will feel "driven" to the conclusion that "in recognizing speech sounds the human ear is not listening to music but indications due to resonance, of the position and gestures of the organs of articulation" (page 126). It may hear both, but what it really listens to is the purposive social use to which the sounds are put. In the primary speech situation, all the senses are important, for meaning is as much a property of the situational context of people, things, and events, as of the sounds made and heard.

It is not clear whether this latest form of the mouth gesture theory, based on acoustics, is put forward to explain the fundamental nature of actual speech, or as a guess at prehistoric origins, or as a contribution to the study of meaning, or all three.

The pronunciation of the simplest word involves, besides certain areas of the cortex and related processes, the whole of the respiratory tract, the diaphragm and certain muscles of the abdomen. The whole of the respiratory mechanism and the larynx, in addition to the supra-glottal articulatory organs, are involved in an integrated motor act. To suggest that the motor background of speech is merely the "under-studying" of manual gesture by "tongue tracking" and lip gesture is clearly unsatisfactory.

The author seeks to strengthen his case by excluding the larynx as a true organ of speech. Apart from the fact that it is

an articulating organ for the glottal stop and consonants with accompanying glottal closure, and for certain types of "h" sound, the larynx gives pitch, and the intonation of the voice is of the greatest affective value in our social life of which speech is the main directive function Besides, pitch can have semantic and grammatical function, and thus be as essential a part of the framework of a language as the inflections of synthetic languages, composed of vowels and consonants It would be quite impossible, for example, to give an account of the morphology and syntax of the West African Efek without regard to the varying pitch of the voice As an explanation of the fundamentals of actual speech, the theory fails

If students of psychology and language find the linguistic chapters naive and fanciful, they have their answer on page 171 "For flights of fancy we are all born fully fledged; but most of us moult early, and our first plumage is not renewed. Those who do not moult, are plucked before their education is completed." It is unfortunate for the author that most of his intelligent readers will have been plucked, and that the poets who have "Intimations" may neglect acoustics, even when presented as brightly and entertainingly as in this book

J. R. FIRTH

The Genetical Theory of Natural Selection. By R. A. FISHER, Sc.D., F R S. (Oxford University Press. 17*s*. 6*d*)

Although this is obviously a first-class book of which the later chapters are brilliant, many will have great difficulty in following parts of it because it is written largely in the language of the mathematician. The author, himself a mathematician, admits in the preface that the book is hard reading, and he is, no doubt, thinking of those endowed with a mentality similar to his own. He suggests that the difficulty of co-operation between the mathematician and the biologist lies in "an enormous and specialized extension of the imaginative faculty which each has experienced in relation to the need of his special subject," an explanation which may not be regarded as satisfactory by those who recognize a basic difference between the mathematical mind and that of the ordinary human being.

The different outlook of the mathematician and the biologist is well exemplified by the author when he says "No practical biologist interested in sexual reproduction would be led to work out the detailed consequences experienced by organisms having three or more sexes; yet what else should he do if he wishes to understand why the sexes are, in fact, always two?" (p ix)

A glance through the book suggests that only a few of the chapters are mathematical because comparatively few contain complex formulae, but anyone of the type I have called "ordinary human being" who has floundered into and got lost in, say, Chapter II, IV or V, will recognize the mathematical bias of the language of some of the other chapters. Perhaps this has been to some extent unavoidable but the author, unlike many mathematicians, shows that he is capable of writing what I may call plain English, especially towards the end of the book, and I feel that in places he has lapsed into "mathematese" when he might have avoided it.

Chapter I, on the Nature of Inheritance, is easy reading, and the argument is that blending inheritance does not exist and that all inheritance is particulate. Chapter II, on the Evolution of Dominance, is one which I feel might have been put in less mathematical language without spoiling the discussion. Chapter VI, on Sexual Reproduction and Selection, VII on Mimicry, and VIII on Man and Society, are much easier to read, and will be readily appreciated, while after that, with occasional lapses, the book is within the understanding of any educated person and will give food for thought to biologists in the widest sense of the term The criticism of birth-control (Chapter XII) merits careful consideration, and although the rules for the foundation of an ideal society, suggested almost apologetically by the author, may be debatable, they should certainly be studied by those who are interested in the destinies of nations

FRANK BALFOUR BROWNE

Manual of Meteorology. Volume III . "The Physical Processes of Weather" By SIR NAPIER SHAW, with the assistance of ELAINE AUSTIN. (Cambridge University Press. 36*s*.)

Sir Napier Shaw's great encyclopaedia of meteorology continues to progress. Having outlined the history of the science in Volume I, and in Volume II summarized all known facts about the distribution of meteorological phenomena on the earth's surface and in the upper air, he proceeds in Volume III to seek the underlying physical processes which govern these phenomena. The subject matter is complex and difficult; there are gaps in our knowledge which make the treatment in places disjointed, but the style is everywhere very clear and Sir Napier has contrived, to the reader's great advantage, to replace much of the usual highly mathematical treatment by a wealth of diagrams.

The greater part of the book deals with the application to meteorology of two main branches of physics, wave-motion and thermodynamics The discussion of wave-motion follows more or less along the customary lines—gravity-waves, sound-waves, atmospheric optics, and the problems of radiation—and is chiefly notable for its thoroughness. The chapter on refraction of sound-waves and zones of abnormal audibility is especially interesting, the latter phenomena have recently been the subject of much discussion and experiment, but it is shown that they are amply accounted for by a stratum of high temperature at great heights, the existence of which is supported by the phenomena of meteors and wireless telegraphy. These refraction phenomena are, however, somewhat of the nature of curiosities, which give valuable insight into the structure of the atmosphere beyond the reach of instruments, but so far as we know have little or no influence on the sequence of weather changes With the two chapters on radiation we get to grips with the latter problem, which for practical purposes is all-important

The discussion of the balance of radiation follows the lines laid down by the late W H. Dines, it is extraordinarily complete, tracing in detail the vicissitudes of a beam of the sun's rays from the time it enters the atmosphere until it emerges again as dark radiation to space Many quantities enter into the calculation, and the rapidity of recent progress may be judged from the fact that while thirty years ago we could only guess at the magnitude of these, the computed outgoing radiation from the earth, air, and clouds now balances the incoming solar radiation, computed quite independently, with an accuracy of two per cent This chapter represents one of the little-known romances of science.

The seasonal variation of solar radiation, modified by the distribution of land, water, and ice, is of paramount importance in weather, and in the middle half of the book we are introduced to the *modus operandi*, the working of the atmospheric heat engine Sir Napier's treatment is basically novel; even his vocabulary would have been unknown to an earlier generation.

For meteorological purposes the important quality of the air is not its pressure or its temperature, but a combination of both, its "entropy," a quantity which is proportional to the store of heat independent of temperature, and inversely proportional to the absolute temperature The conception is difficult, but fundamental, for the distribution of entropy governs the stability of the atmosphere

These brief descriptions do not by any means exhaust the scope of the book; there is, for example, a long chapter of great interest on "Electrical energy in the atmosphere," and in fact, the whole length of this review is much shorter than the table of contents. The amount of information packed into the volume is amazing. The excellent index alone covers twenty-three pages, and, looking through it, one would say that Sir Napier Shaw and his able assistant, Miss Austin, seem to approach the omniscient in meteorology It remains only to add that the Syndics of the Cambridge University Press have done their share by producing a neat and presentable, if somewhat weighty volume

C. E. P. BROOKS

British Documents on the Origins of the War, 1898-1914 Volume VI Selected and edited by G P. GOOCH, D.Litt, F B.A, and HAROLD TEMPERLEY, Litt.D., F.B.A (H M Stationery Office. 17*s* 6*d*).

From the point of view of the general public, this latest volume of documents on the origins of the war will be of even greater interest than its predecessors. The period covered is the years 1907 to 1912, when the situation between England and Germany was distinctly strained and so many efforts were made by negotiation to relax the tension that existed. The series under review is being published in eleven volumes, of which seven have now appeared. It will be remembered that the decision to publish a selection from these official documents was taken in the summer of 1924 by Mr. Ramsay MacDonald, as Secretary of State for Foreign Affairs, and announced by his successor Mr. (now Sir) Austen Chamberlain later in the same year Volume XI was published first, and dealt with the period 28th June—4th August, 1914 Volumes I and II began with the year 1898, when certain influential members of the British Cabinet, alarmed by the hostility of France and Russia, desired to substitute a policy of alliances for the traditional principle of "splendid isolation" They ended with the conclusion of the Anglo-French Treaties of 8th April, 1904 The first Morocco crisis of 1904-6 was the subject of Volume III, while IV and V described British relations with Russia (1903-7) and the Near East situation, taking the story right up to the close of the crisis produced by the Austro-Hungarian annexation of Bosnia.

In the years covered by the new volume, the main topics of discussion were the question of naval armaments, the possibility of limiting their increase by mutual agreement between Great Britain and Germany; and the German proposal for a political formula as a preliminary to such limitation. The Bagdad railway and the question of Persia were important subsidiary topics. The most serious attempts to solve these problems are to be found in the Bethmann Hollweg proposals of 1909, the Gwinner-Cassel negotiations which immediately followed, and the long drawn out discussion culminating in the Haldane Mission of 1912. During the year 1911 the important question of Morocco brought Great Britain and Germany to the verge of war over the crisis of Agadir. But this very serious incident did not in fact terminate the discussions on limitation of armaments, and is reserved for full separate treatment in the seventh volume to appear later.

Representative extracts from the newspapers have been given, and special care has been taken to reproduce the summaries of the German press provided by Sir Fairfax Cartwright, and the impression produced on English statesmen by these opinions. The German Emperor's views are reported very fully in many conversations with diplomatic and other representatives. Nearly all the documents in the present volume are now published for the first time.

The Magic of the Stars. By MAURICE MAETERLINCK. Translated by ALFRED SUTRO. (Allen & Unwin. 6*s*)

Those who are acquainted with Maeterlinck's writings will expect to find here a poetical account of the marvels of the heavens; and in this they will not be disappointed. The book contains many attractive word-pictures. However, the author has not specialized in astronomy, and the volume is not recommended as adequate for those who desire a full and exact description of the sidereal systems in the light of the latest knowledge. There are many misleading statements. On page 26 we find the sentence, "In 1884 only eighteen stars of variable light were known, and these were watched by five observers" Actually the 1881 edition of Webb's *Celestial Objects* contains 134 variable stars, and that list did not include all that were then known On page 32 we find " . . this system, that as one solid mass turns in the direction of Capricorn, speeding through the celestial vault at the rate of 400 miles a second" This is misleading, the centre of rotation is not in Capricorn, but between Sagittarius and Ophiuchus, according to the latest computations, and the motion is not in the direction of the centre, but at right angles to that direction; nor does the rotation take place "as one solid mass", the methods by which it was detected and measured depend on the difference of angular speeds at different distances from the centre. The same error is found on page 131, " . the Milky Way . . has been heading for the Capricorn at the rate of 450 miles a second." On page 122 it is stated of Mars "It is almost certain that vegetation there can be none." It would be easy to enumerate many well-known Martian observers who hold a contrary view On page 123 the diameter of the image of Mars in a certain telescope is given as two metres, instead of two millimetres

The philosophy of the book may be described as depressing; on page 69 we read, "In a thousand million centuries all will be as it is to-day, as it was a thousand million centuries ago; as it was at the beginning—and there could have been none; as it will be at the end—and there can be no end." It is matter for surprise to find the author making this statement so confidently, seeing that in the list of authorities at the beginning of the book he gives pride of place to Sir J. H. Jeans, of whom he says (on page 17), "He is at present one of the leading exponents of astrophysics." Now Jeans is absolutely against the idea of the infinite duration of the universe either in the past or future. He assigns its beginning to an epoch some five to eight millions of millions of years ago, and predicts its end after a longer, but still comparable time-interval in the future. He compares it to a clock that is running down, and is unable to indicate any process by which the rewinding might be effected; he ascribes the continued shining of the stars to the conversion of matter into radiant energy, but shows the difficulties that

arise in postulating the reconversion of this radiant energy into matter.

It is probable that Maeterlinck's assumption of the past eternity of the universe is based on a desire to dispense with a Creator Even he, however, is driven to adopt the conception of the presence of "Demiurges" (he adopts this word, used by the Gnostics of old). He makes a sort of god of the earth, thus he says on pages 80 and 81, "At its beginning it (the earth) was more intelligent than we shall be at its end. . There is not the smallest thing we know that the earth has not known these many thousands of centuries. . . The earth contrived this brain of ours, and, to do that, it must of necessity have had a brain that was superior, just as a watchmaker must be more intelligent than his watches."

Elsewhere in the book the author refers with favour to the suggestion of Sir Francis Younghusband, in *Life in the Stars*, that the dawn of human intelligence may have arisen through communications sent by wireless waves, or in some similar manner, from other worlds It is clear that, even if this were the case, it would merely shift the problem of the origin of intelligence back a step, without giving an adequate explanation of it.

A C D. CROMMELIN.

The Mechanism of Nature. By E N. DA C. ANDRADE, D Sc, Ph.D. (Bell & Sons. 6s)

It is the business of a reviewer, particularly of "popular" scientific books, to say, in the light of his experience, exactly what he thinks of the book under notice, regardless alike of possible charges of either fulsomeness or rudeness. "The Mechanism of Nature" is one of the best books of its kind that I have ever seen. One other which occurs to me as a comparison is Sir William Bragg's "Concerning the Nature of Things," which approximates to the ideal presentation of scientific phenomena in popular language.

Judging by the large number of scientific books written for the delectation of the non-professional scientific reader, the demand for scientific knowledge must be both considerable and at the same time definitely uncritical; therefore it is a great pleasure to read such a book which is both interesting and accurate. Professor Andrade needs no introduction He is a well-known and accepted authority on scientific matters. He is also an accomplished commentator on science in that he is an expert in the art of analogy which, when it is used with knowledge and ingenuity, is supremely valuable in this connexion. At the same time it is a dangerous weapon in the hands of the unskilful.

The book deals with fundamental principles in modern physics. After defining the nature and scope of the study of physical science the author proceeds to treat of energy in its various manifestations. He devotes many pages to a consideration of the various well-known forms of radiation, such as light, X-rays, wireless waves, and so on, and their generation is explained in terms of current atomic theory. Wave motion is treated in considerable detail and developed into a description of the modern subject of wave-mechanics due to De Broglie and Schrödinger. One particularly valuable part of the book explains black body radiation and its significance in the development of the quantum theory. This subject is rarely understood by the layman, who is frequently puzzled by the technical term.

The notion of entropy seems of late years to have emerged from its original quiet setting as a somewhat special mathematical expression pertaining to thermo-dynamics, and to have achieved almost a fundamental position in the limelight of modern philosophy. The conception is not an easy one for the non-mathematical reader, but Professor Andrade succeeds in conveying quite a valuable idea of it in picturesque and graphic terms

I am glad to notice that the author frequently emphasizes the statistical nature of physical laws, a most important aspect of science for the layman, by means of carefully chosen and apt illustrations The book will be read with great interest and profit by all who are interested in the progress of modern science, and unlike many popular books it will be thoroughly enjoyed by the professional man of science whose business in life it is to learn

V. E. PULLIN.

Orokaiva Society By F E. WILLIAMS, M A. With an Introduction by SIR HUBERT MURRAY, K C M.G. (Oxford University Press 25s)

The Orokaiva occupy the greater part of the northern territory of Papua, and the present volume, the author of which is Government Anthropologist, is the tenth published report of the Papuan Government on anthropology. In his introduction the author dwells upon the advantage from the practical point of view of his studies in the administration of the native of New Guinea This is a point of view which cannot be impressed too often upon the public at home, in presenting material dealing with the customs and beliefs of the primitive peoples under our rule, especially at the moment. A public opinion more fully informed as to the racial problems of India might have done much to lighten, if not avert, our present difficulties. Mr. Williams' book is not entirely local in its bearing, although he has had the needs of his fellow officials prominently in his mind. It is true he has confined his work almost entirely to description, and has, generally speaking, refrained from interpretation, but at the same time his work has a wide appeal, both in the range of its subject matter, and in its value for comparative study. The Papuan native is among the most primitive of peoples now surviving, and for comparative work, their social organizations and ritual practises are of first-rate importance.

Three of Them By NORMAN DOUGLAS. (Chatto & Windus. 6s.).

The title suggests many things, but the book is so named because it includes three essays written in 1920, 1901 and 1891, two of which, perhaps all three, appear for a second time. "Nerinda" and "One Day" are written in an obscure style which, using a term usually applied to pictures, I should call "impressionist"

The earliest essay, "On the Herpetology of the Grand Duchy of Baden," was originally published in the *Zoologist*, where it appeared during 1891 in seven sections under the authorship of G. Norman Douglass This was an excellent account of the reptiles and amphibians of Baden, their distribution, habits, and the nature of their habitats, with occasional reference to general questions such as the causes of melanism, of isolated areas of distribution, etc. But although the paper was no doubt of considerable value at the time of its first appearance, it is now thirty-nine years out of date It is, however, interesting as showing a complete change of style on the part of the author.

FRANK BALFOUR BROWNE.

DISCOVERY

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Editorial Notes.

ABOUT a year ago we noted in these columns that Sir Hubert Wilkins was planning to explore the North Pole in a submarine. Nothing more had been heard of the project until last month, when it was confirmed by the explorer himself in an interview with the London *News-Chronicle*. According to this latest information, the expedition will be made in an American submarine, and its estimated cost is £100,000. Sir Hubert expects to set out next May, and will make Spitzbergen the starting-point of a voyage across the Pole to Alaska. The distance to be travelled is about two thousand miles, which should take fifty days to accomplish in the submarine. "Whenever we find that the ice blocks our course," Sir Hubert stated, "we will simply submerge and trick Nature that way." He estimates that the average thickness of the ice will be about ten feet, but it will probably be necessary to submerge to a depth of twenty-five feet. The submarine has been constructed for remaining below the ice for two and one half days at a time. It is 375 feet long, weighs 350 tons, and is propelled by an engine of 500 horse-power. The speed is fourteen knots on the surface and nine knots submerged, but it is expected that less than four miles per hour will be the average rate of progress under the ice. The scientists and crew will number eighteen altogether. The party will be international in character, and is to include British, Americans, Germans and Dutchmen. The leader of the expedition does not anticipate that food supplies will present any difficulty. One of his objects, in fact, is to show that a submarine can land provisions at the Pole, thus advancing greatly the possibility of maintaining a depot all the year round. Sir Hubert's plans include the making of a continuous talking-film record of his journey. He also intends to broadcast accounts of the submarine's progress. This would naturally be carried out from the surface and, as he told his interviewer, it should be a thrilling moment when he concludes the daily message—"*Au revoir*, everybody. We are now submerging."

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The discoveries in Mesopotamia since the war have been so brilliant and numerous that fresh finds are now taken almost for granted. The widespread interest aroused in Ur of the Chaldees is mainly due to Mr Leonard Woolley, whose skill in explaining its story to the public is only equalled by his ability as an excavator. As a measure of his success it may, indeed, be admitted that some of his readers are by now inclined to tire of the graves and their rich contents. For this reason the latest discoveries are specially welcome, as they throw the whole picture into perspective. The early chapters of *Genesis* have always fired the imagination, and now for the first time is revealed the historical basis of much that was thought to be legendary. The new evidence of the Flood discovered last autumn, was followed by remarkable facts about the canal system of Ur, which make it clear that this ancient city on the Euphrates was not unlike the Venice of to-day. To preserve the buildings from the river waters and constant floods, a massive wall was erected, with which were associated some of the most beautiful buildings yet unearthed in Mesopotamia. These and other features of the season's work are reviewed on another page by Mr. M. E. L. Mallowan.

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The latest report of the British Empire Cancer Campaign contains much evidence of the progress

that is being made in fighting this disease. The system of correlating the results of research has been improved, so as to avoid overlapping, and it is now possible for workers in one institution to profit by the discoveries in another with the least amount of delay. Progress in actual research includes the discovery that "mustard gas"—the poison which wrought such havoc during the war—possesses powers of preventing the onset of cancer in areas of the skin to which cancer-producing tars have been applied. This work was undertaken at the University of Leeds. It is, of course, well known that certain tars may cause cancer, and the increased use of these substances in modern conditions is thought by some experts to be a possible explanation for the spread of the disease. The action of the mustard gas is localized to the particular area and is strictly limited in time, but is none the less on that account a remarkable one. The mustard gas does not prevent the active growth of skin which follows the application of tar and precedes the formation of cancer. It seems, therefore, to be the first true anti-carcinagenic agent ever discovered.

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A new record in deep-sea diving has been accomplished in Bermuda waters by Dr. William Beebe, the well-known American naturalist. "Battened down" in a steel sphere of approximately five feet internal diameter he descended with another explorer, Mr. Otis Barton, to a depth of 1,426 feet. The apparatus contained oxygen tanks, with chemicals for absorbing the breathed air, and was lowered by cable from a ship. A telephone wire maintained connexion with the crew above, and the explorers described what they observed from the sphere. According to *The Times*, Dr. Beebe found that at 1,400 feet most of the light from the sun had been cut off by the intervening water, only the rays at the blue-violet end of the spectrum penetrating to this depth. He was, nevertheless, able to observe the fishes that swam past the windows of the sphere. Most of them belonged to the class which carry their own lighting systems—showing a great variety of structure but all depending, apparently, on luciferin and luciferase, two chemicals of which little is so far known.

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The practice of issuing books with titles that do not describe their contents was criticized recently by one of our reviewers. The other extreme is, of course, often met with in the case of scientific subjects, when a readable story is obscured by the forbidding description on the cover. A happy combination has been chosen by Mr. Sidney de la Rue for his book, "The Land of the Pepper Bird: Liberia" (Harrap), which gives a picture of that remarkable black republic on the west coast of Africa. Very little has hitherto been written about Liberia, and the author is well qualified to do so, having spent several years there in the official capacity of Financial Adviser. Apart from its growing importance in world trade, the country affords an interesting study in native government and politics. Mr. de la Rue describes the customs of the people and their economic problems, and devotes several interesting chapters to native cults and the dread Black Magic.

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It is now possible to see London from the air while taking a cup of afternoon tea. On Fridays, Saturdays and Sundays throughout the summer, Imperial Airways are providing this novel entertainment, which occupies only two hours and costs two guineas. Passengers for these "tea flights" leave Airways House, Charles Street, at 2.30 p.m., and drive by car to Croydon aerodrome, where a Silver Wing air liner awaits them. During the next half hour they cruise over London, and while tea is served they are afforded an entirely new impression of the world's greatest city. Those who have not flown before will probably be most impressed by the extraordinary "neatness" of everything, as one by one the familiar landmarks appear in miniature below. Bad sailors need not be deterred by air sickness—we write from experience—as in the short space of half an hour there is not time to become affected by dizziness, which sometimes makes long distance flying so intolerable.

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The articles in our British Association Number next month will be closely related to the Bristol proceedings. There will be a biographical sketch and portrait of the President, Professor F. O. Bower, some advance notes on the meeting referring to the principal subjects for discussion; and a valuable review of the Association's activities since the war, written specially for *Discovery* by the Secretary, Mr. O. J. R. Howarth The period has been notable as including among its presidents the Prince of Wales, and there have been two overseas meetings since 1920, in To onto and in Cape Town. Readers visiting Bristol will be interested to hear that another contributor is to discuss the scientific aspects of the tobacco industry, which is so closely associated with the city. Lastly, the Vice-Chancellor, Dr. Thomas Loveday, will describe the University of Bristol, so resuming the series of articles on British universities that was commenced in the spring The Centenary of the Association will be celebrated in London next year.

How Pluto was Discovered.

By Henry Norris Russell, Ph.D.

Director of the Observatory at Princeton University, U.S.A.

The recent discovery of a new planet has been followed by much controversy on the true nature of the object. In the opinion of our contributor, there can be no doubt that it is actually a major planet, much farther away than any previously known. The name Pluto has just been assigned to it by American astronomers.

THE widespread and justified sensation caused by the discovery of the new major planet of our solar system will have passed long before these words appear in print. But the discovery itself is so important and illustrates so well the methods of modern astronomy that it should not fail to be set out in order here.

Everyone knows how Neptune, the last great planet to be discovered, was found. After Uranus had been known for half a century or more it was found to deviate from the orbit determined from the first fifty years of observations, after full allowance had been made for the attraction of the then known planets. Some unknown body must be pulling at it, and this could only be a planet still farther from the sun. To calculate from the observed perturbations of Uranus' motion the orbit of the unknown planet which produced them was a very intricate matter. But the problem was solved by Le Verrier in France and Adams in England, and the planet Neptune was found within a degree or so of the place in the heavens which these calculations pointed out.

Through all the eighty-four years since the discovery of Neptune, the possibility that there was a still remoter planet has been realized, and now that Pluto has been discovered the layman natural may ask, " Why, if it was there all the time, did not the mathematicians tell us where to find it? " As a matter of fact they did, but through no fault of theirs their answer could not be as precise as it was for the earlier problem of Neptune.

A Difficult Task.

To calculate the perturbations produced in the motion of one planet by the attraction of another is no small task, even when the orbits of both are accurately known in advance; and to work backward from the perturbations of a known planet to the orbit of an unknown one is much harder. But mathematical astronomers are used to hard problems and know how to solve this one. The worst difficulty is that to find the perturbations we must compare the observed positions of the known planet with those which it *would have had* if the unknown planet had not been attracted. To determine the latter is evidently difficult.

To see how it can be done let us ignore the attractions of the known planets (or suppose that, as in practice, their effects have been calculated and allowed for). We then know that, barring unknown influences, the planet should move in an exact ellipse about the sun in accordance with Kepler's familiar laws. What the size and shape of this ellipse may be can be found only by observing the planet. If no extraneous forces are acting, the planet will follow the same ellipse time after time, but if an unknown planet is perturbing it the tracks in the second and subsequent revolution will not be quite the same, and the differences will reveal the amount and nature of the perturbations.

Prediction Methods.

It is not actually necessary to wait quite so long. When a planet has been well observed half around its orbit, its motion along the other half can be predicted closely enough to reveal any considerable disturbances after it has been followed in this half as well. But something like a full revolution around the sun is really necessary. With observations covering only half the orbit or less, it is possible to find a " fictitious orbit " such that a planet moving in it without perturbations (save by the attractions of known bodies) will, *over the given interval of time*, always be very near the real planet—subject though it is to additional perturbations, and though in earlier or later years this will not be true.

It may help to understand this to imagine a circular hoop which has been bent and battered a little out of shape (see page 253). If we can see the whole hoop or half a photograph of it it is easy enough to strike a true circle which follows its general course, and then find the amount of the deformations from point to point. But if our photograph covers but a small part of the hoop and we try to fit a circle to it as best we can, we may draw it too large or too small, according as this particular part of the hoop has been flattened or bent too sharply.

The heavy line in the diagram represents a battered hoop which in a rough way illustrates a perturbed orbit. The circle represents the hoop before it was deformed, or the unperturbed orbit. But if we knew only the part AB of the hoop we would suppose that the whole was like the dotted circle and would greatly under-estimate the amount, and sometimes even the direction, in which this portion had been bent out of shape. In quite the same way we cannot get any accurate idea of the perturbations of a planet unless we have observations extending pretty well around the orbit.

Now since its discovery in 1846 Neptune has been only halfway around its orbit, and it is therefore practically valueless for locating an outer planet by means of its perturbations. Uranus has completed two revolutions since its discovery and is fully available, but it is nearer the sun and farther from the trans-Neptunian planet and the perturbations to be anticipated are therefore small.

Preliminary Problems.

Several investigators have examined the question, the most comprehensive work being probably that of the late Dr. Percival Lowell, which was published in 1914 but commenced more than a decade earlier. A careful mathematical investigation indicated the existence of small perturbations just within the limit of detection, and indicated that the unknown planet which produced them must be either in the direction of the constellation Gemini or just on the opposite side of the sun. The perturbations produced by planets in these two positions were so much alike that no decisive choice between the two could be made.

Lowell estimated the new planet's distance from the sun as 43 to 44.7 astronomical units—half as much again as Neptune's—and its mass as 1/50,000th that of the sun, six times the earth's, but only one-third of that of Uranus or Neptune. Accepting these conclusions, the next question was how to find the planet. Being less massive than Neptune it was doubtless smaller, and being far from the sun it must be faintly illuminated and far from conspicuous. Lowell estimated its probable brightness as from the 12th to the 13th magnitude. It is hopeless to search for such an object visually among the multitudes of stars, and the only chance of success is by photography, employing substantially the same methods as have been proved so successful in finding asteroids; that is, the careful comparison of suitably duplicated plates of the same star fields.

A great deal of time and labour was thus spent by Dr. Lowell and his successors at the observatory which he founded at Flagstaff, Arizona, and which bears his name. In time it became clear that the distant planet was probably fainter than the original estimate, which in the nature of the case could only be very rough, and that a very powerful instrument would be required to find it. A gift from the President of Harvard, Percival Lowell's younger brother, provided an admirable instrument. It possesses a triple objective of thirteen inches aperture which gives sharp star images over a wide field, and is withal very rapid.

The new Lawrence Lowell telescope within a year of its installation has brought the long-sought planet to light. Photographs of moderate exposure covering the whole region of the heavens around the predicted position were obtained, and on one of them, taken on 21st January, 1930, Mr. Tombaugh of the observatory staff found "a very promising object." It was identified from its motion past the numerous fixed stars as revealed on plates of the same star field while being compared under the blink comparator. This showed that one faint star among many thousands had shifted its place by a certain expected order of distance, in the interval between the taking of the two plates. Since that date it has been carefully followed both photographically by Dr. Lampland with the 40-inch reflector, and visually by E. C. Slipher and other members of the staff. Its motion in the heavens has been just what might be expected of a trans-Neptunian planet at about the distance anticipated by Lowell, and its longitude agrees closely with his predictions. There is no doubt that it is actually a new major planet much farther away than any which has previously been known.

This admirable discovery comes to the astronomers at Flagstaff as a reward of years of skilful development of methods and patient work. It is most gratifying that this long and devoted search has been crowned with full success, though we must all regret that the originator and inspirer of the campaign did not live to witness its triumphant close.

Observing the Orbit.

What of the new planet itself? Full knowledge comparable to that which we have regarding the other planets of our system can come only after years of further work. For example, it will be a long time before its orbit is accurately known. A fairly good orbit of a rapidly moving asteroid can be derived from three good observations separated by intervals of a week or so. For this slowly moving body intervals of a couple of months will be desirable. Before it was lost in the light of the sun, which happened in May,

sufficient data to give a good preliminary orbit, which will tell us where to look for the planet at the end of summer when it can again be observed, was worked out and published (12th April). Next year's observations will permit a considerably better determination; and so on.

Even after a decade, however, we will have observations covering only a very small fraction of the orbit and will still be somewhat in the position of having to determine the course of a whole circle from a small arc. It may happen that, calculating backward, the images of the planet can be found on photographs taken years before it was discovered, though it is so faint that the chance is not very good. And in this case the arc available for determining the orbit, and the calculated results, may be increased. At this early date we can be certain only that the planet is near the ecliptic, that it is moving around the sun in the same direction as the other planets, and that the inclination of its orbit plane, while greater than the other planets, as Lowell predicted, is not extremely great. The general agreement of its apparent motion with that calculated with Lowell's estimated distance of 43 to 44.7 astronomical units shows, however, that this prediction is near the truth.

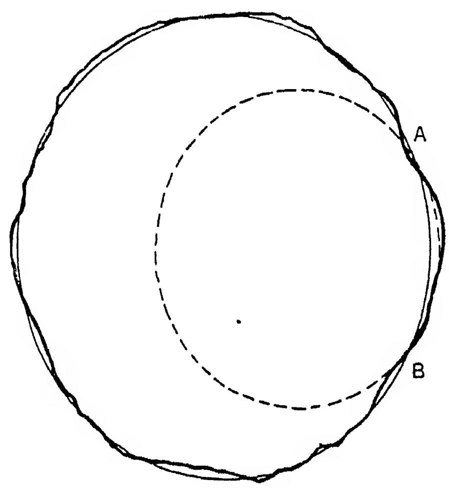


Diagram of the perturbed orbit of a planet, showing how when only a portion (AB) has been observed the true orbit may be greatly underestimated

Adopting provisionally this distance, which is fifty per cent greater than Neptune's, what else can now be said about the planet? Its diameter must be rather small. With the 24-inch refractor at Flagstaff the planet appears as a faint stellar point and shows no sensible disc.

If it were really as much as 10,000 miles in diameter it would show an apparent disc of $0''.5$, which the experienced observers who have examined it hardly could have missed under favourable conditions. We may conclude with some confidence therefore that the new planet is little if at all larger than our earth—provided, to be sure, that the estimate of its distance here adopted is correct.

Further evidence that the planet is a small one is found in its faintness. The assigned magnitude, about 15.5, is photographic. If it is of the average colour of the inner planets it should be about a magnitude brighter visually than photographically, and we may base our estimates on a visual magnitude of 14 or 14.7. This makes the planet only about 1/250th as bright, apparently, as Neptune. If Neptune could be removed to this greater distance it would look only one-fifth as bright as it does now, but even so it would outshine Pluto fifty-fold. This suggests that the diameter of the new planet is about one-seventh that of Neptune, or a little less than 3,000 miles. This estimate, however, may be too small, for Neptune has the highest superficial reflecting power, or albedo, of any of the planets, and a planet of lower albedo would have to be larger to reflect the same amount of light. To go to the opposite extreme we may take for comparison the moon, which has about the lowest known albedo. A simple calculation shows that if removed to a distance of 45 astronomical units from us and from the sun, she would appear as a star of visual magnitude 17. Now Pluto appears three magnitudes or sixteen times brighter, which on this hypothesis regarding its surface brightness makes its diameter four times that of the moon, or 8,600 miles. It is probable that the truth lies between these two estimates, but little more can be said, for there are very great differences of albedo even among the atmosphereless asteroids, and we have no means of estimating more closely what value we should use for the new planet. It may be considered, nevertheless, that it is fairly comparable in size with the four inner planets of our system, and much smaller than the four outer ones which were previously known.

The planet's mass can probably be determined at least roughly from the perturbations it produces in Uranus and Neptune when once its orbit is accurately known. The latter statement may seem inconsistent with what has already been said, but the problem here is not quite the same as before. Suppose that, in the diagram, we knew the direction in which the wavy line deviated from the circle at each point and the relative though not the absolute amounts of these deviations. We would then have much less latitude in drawing our theoretical circle than before, and could be fairly sure of its position in cases which before were hopeless, as already explained.

A planet less than 10,000 miles in diameter would be very unlikely to have a mass 1/50,000 that of our

sun, for this would demand a mean density about seventeen times that of water. The earth's mass is only 1/330,000th of the sun's, and if Pluto is no more massive it is hard to see how its attraction could produce the effects studied by Lowell. This discrepancy would be diminished if the planet's distance from the sun should turn out to be greater, but it is premature to discuss the matter further at present, without more dependable data.

The only hope of learning anything about the rotation of the new planet is by photometric means. If, like many of the asteroids, it should show regular periodic changes in brightness, these would reveal the rotation. But for so faint an object, the observations would be difficult. Finally, there is little hope of detecting a satellite of the planet unless, like our moon, it should be almost comparable in size with its primary. Nevertheless, it is probable that photographs will be made with the great reflectors, in order to investigate.

In conclusion, two tributes must be paid where honour is due: first, to the skill, assiduity, and devotion of the workers at the Lowell Observatory who have made this important discovery; and, second, to the memory of Percival Lowell, traveller, man of letters and affairs, and observer of the planets. He did many things in the course of a crowded life and did them well. The mathematical researches took him outside his other fields of work and into a region full of traps for the unwary, yet the discovery of this new planet has justified him by his works despite the doubts of many of his contemporaries. His fame bids fair to increase as the years pass on.

The Cinema Aids Astronomy.

An important advance in the technique of astronomy has resulted from the demands of the motion picture industry. It often happens that something discovered in the laboratory afterwards meets commercial requirements, but the reverse is not so common. A need arose for cinema films which would permit the taking of night scenes during the daytime, since great expense could thereby be saved. It has long been known to photographers that a plate exposed to the invisible part of the solar spectrum produces a picture that looks very much as though it had been taken at night. The sky, for example, comes out dark instead of light. But the method employed was unsuitable for commercial requirements. It was thus that experiments were made in the Kodak laboratories under the direction of Dr. Mees, which resulted in the discovery of dyes that would serve the required purpose. A report on the subject has just been issued by the Carnegie Institution of Washington.

The earliest method of photographing the "infra-red" rays was used by Sir William Abney nearly fifty years ago. His results were obtained with a special form of silver bromide which had the power of absorbing red and infra-red radiation, he used no dyes. He prepared his own photographic plates shortly before using them, employing an elaborate process which is troublesome and uncertain. It has never been seriously applied to modern spectroscopy, though the resources of the present chemical laboratory would perhaps warrant a revival of it.

Neocyanine.

The most important of the new dyes is called Neocyanine, and is produced in the form of beautiful red crystals which are soluble in alcohol. An ordinary photographic plate treated with this solution acquires infra-red sensitivity far beyond that obtainable with other chemicals. As applied to astronomy, the importance of this discovery is that the light from the sun can now be analysed much more accurately than has been possible hitherto. A filter is used on the spectrograph which stops the visible light and transmits the invisible rays. The plate is exposed to this for about seven hours, and then developed in total darkness. By means of this method hundreds of spectral lines emanating from atoms in the sun's atmosphere are now being accurately measured for the first time. As carbon is among the most abundant elements in the earth, we should expect it to be abundant in the sun also, since the best tests that can be made indicate that the sun affords a fair chemical sample of the material universe.

Hitherto the only evidence of the presence of atomic carbon in the sun was that indicated by nine faint lines in the visible part of the spectrum. Although conclusive, this evidence is not very impressive when compared with that for other equally abundant elements. The fact is that throughout the visible and near ultra-violet, carbon atoms have no strong lines and only a few weak ones. When studied in the electric arc, however, the carbon atom is known to produce a group of very strong lines in the infra-red. The photographs obtained with the new dyes show these same lines, but, since their accuracy is greater than in the case of the electric arc, the solar data more completely correspond with the predictions of the atomic theory than do those of the laboratory.

These researches afford an excellent example of the continuity of scientific progress, which is more often evolutionary than revolutionary in character.

Excavations at Ur, 1929-30.

By M. E. L. Mallowan, M.A.

A member of Mr. Woolley's expedition here describes the latest discoveries at Ur. The new evidence relating to the beginnings and the end of the city's history, makes it clear that the measure of man's success in Southern Mesopotamia, then as to-day, was his ability to cope with the water problem.

By the end of March, 1930, the joint expedition of the British Museum and the Museum of the University of Pennsylvania, had completed its eighth consecutive season in the field. Mr. C. Leonard Woolley, the director, once again had ample reason to be satisfied with his campaign. The programme consisted of three main items: the excavation of a pre-historic site over an area large enough to be capable of supplying copious evidence of the beginnings of the city's history and the context of the Flood, the completion of the Royal Cemetery and the establishment of its confines; and, lastly, the excavation of the main city wall and the canal system.

The Prehistoric Background.

The first two tasks proceeded concurrently, and kept a gang of some two hundred men busy from the beginning of November till the middle of January. It is no small tribute to the powers of work of the supposed congenitally idle Arab that by the middle of March the complete circuit of the city wall, some two and a half miles in length, had been compassed. Above all, Hamoudi, our well-tried Arab foreman and his three sons, deserve a full measure of praise for an indefatigable energy that stimulated the vigour of the gangs under their charge and developed the intelligent enthusiasm of the more skilful pick men.

For the pre-historic dig a site roughly 600 square yards in area was selected within the Temenos. This particular site was chosen for two reasons. First, because it had been considerably denuded in antiquity, and the uppermost level could be dated by its potsherds to before 3200 B.C., and secondly, because it lay in the vicinity of deep pre-historic rubbish heaps large and rich enough in content to indicate that the higher ground from which they had accumulated was a mine of early habitation. Yet though work was begun at a level containing buildings over 5,000 years old, the gangs had to descend sixty feet into the bowels of the earth through a continuous series of occupation levels before virgin soil was reached. Here we laid bare the pre-historic background for the picture of greater Ur as revealed to us in the Royal Cemetery and in the city fortifications of the second millenium before Christ.

From the surface excavation proceeded through eight distinct strata, each of which contained private houses built in mud brick. There was considerable change in the character of the brickwork for the different levels. There were plano-convex mud bricks, oblong flat top bricks, and in the eighth level walls of heavy limestone foundations. The variety of construction is, perhaps, an index of length of occupation, but most decisive is the thickness of the walls, often as great as sixteen feet. This means that a fair period of time must be assigned as an average occupation length, for houses so substantial in construction cannot have been rapidly abandoned. An average length of fifty years for each level can hardly be considered excessive, and may be considerably short of the mark Moreover, the objects associated with the houses showed a definite change in character according to the depth at which they were found. From the floors of beaten mud, a mass of pottery was recovered and associated with distinctive levels, gave a type series of inestimable value for the most ancient periods of the city's history.

Painted Wares.

The most striking feature was the emergence of painted wares as opposed to the plain undecorated wares that characterize later Sumerian history. From the fourth level came a peculiar form of painted pottery that has been termed "Reserved slip ware," the paint being applied to the whole body of the pot and then wiped off at intervals so as to produce a series of striations. Lower down came a brilliant three-coloured ware in black, red, and buff, and splendid specimens of plum-coloured wares already found at Jemdet Nasr, a pre-historic site in the neighbourhood of Kish. Here was another marked phase in the history of early Ceramics. In the ninth occupation level there was a sudden change. Instead of private houses, a level of kilns for the baking of pottery. Here were found kilns with the pots neatly stacked inside as they had been left from the last firing, puddling

basins of cement bricks for the kneading of the clay (Fig 1), and throughout this level a mass of wasters, the throw-outs of the early potter In this rubbish at a depth of twenty-eight and a half feet below the surface was found the statuette of a soapstone boar, the earliest piece of stone sculpture in the round ever found in Mesopotamia. Executed in about 4,000 B.C., conventional, at the same time lithe and vigorous, with a real feeling for nature, it is a new adornment to the gallery of ancient art (Fig. 2).

The Great Flood.

Beneath the kiln level at a depth of forty feet below the surface of 3200 B.C., we again uncovered the great flood bank. In the previous season the bank had been discovered in trial pits of more modest dimensions. Here it was unmistakably revealed for the benefit of those who still doubted, over a far larger area. A great belt of clean sand approximately 11 feet deep, entirely devoid of building. But intrusive in it were graves, and some of their occupants must have been contemporaneous with the Flood. These burials again afforded striking evidence of a different cultural phase. Instead of being slightly flexed as in the historic period, or crouched as in the Jemdet Nasr period above the kiln level, the bodies were fully extended (Fig. 4); the painted pottery dedicated as offerings in the graves was of an entirely different type, consisting of plain bands of black on white or greenish clay, or designs in chocolate brown on a reddish clay. The earliest burials were laid on a pavement of potsherds, and the designs were richer and more elaborate, the shapes more varied.

But the most important hall-mark of a high antiquity is the hand-made as opposed to the wheel-made pot. All the Diluvian and ante-Diluvian pottery from this site is hand-made. In the kiln level the chance finding of a potter's wheel corresponded with the prevalence of wheel-made over hand-made pottery. The older type of hand-made pot with its distinctive decoration gradually disappears in the later level. In a word, the Flood stratum marks the transition to a mechanical age.

Below the Flood bank in the earliest of all the occupation levels were found remains of a fallen wall of clay bricks and fragments of a reed hut preserved for us by the accident of a fire. Below them again came virgin soil; a dark viscous clay containing decayed reeds, tree trunks, and organic matter. This was the island in a marsh on which the early Ur first came into being, where, as *Genesis* tells us, " God let dry land appear,"—in other words, the alluvium that first gave *terra firma* to Mesopotamian man.

While a variety of evidence, much of which was entirely new to Mesopotamian archaeology, was being sifted on the pre-historic site, the Royal Cemetery was providing information that both corroborated the evidence from the pre-historic town and fixed its own limits, in space and time. In the previous season it had become evident that the limits of the Cemetery had been for the most parts ascertained. It was therefore highly satisfactory that the stratification of the south-west end provided decisive evidence. From seal impressions stamped with royal names we were able to date the main Cemetery to between 3100 and 3500 B.C.

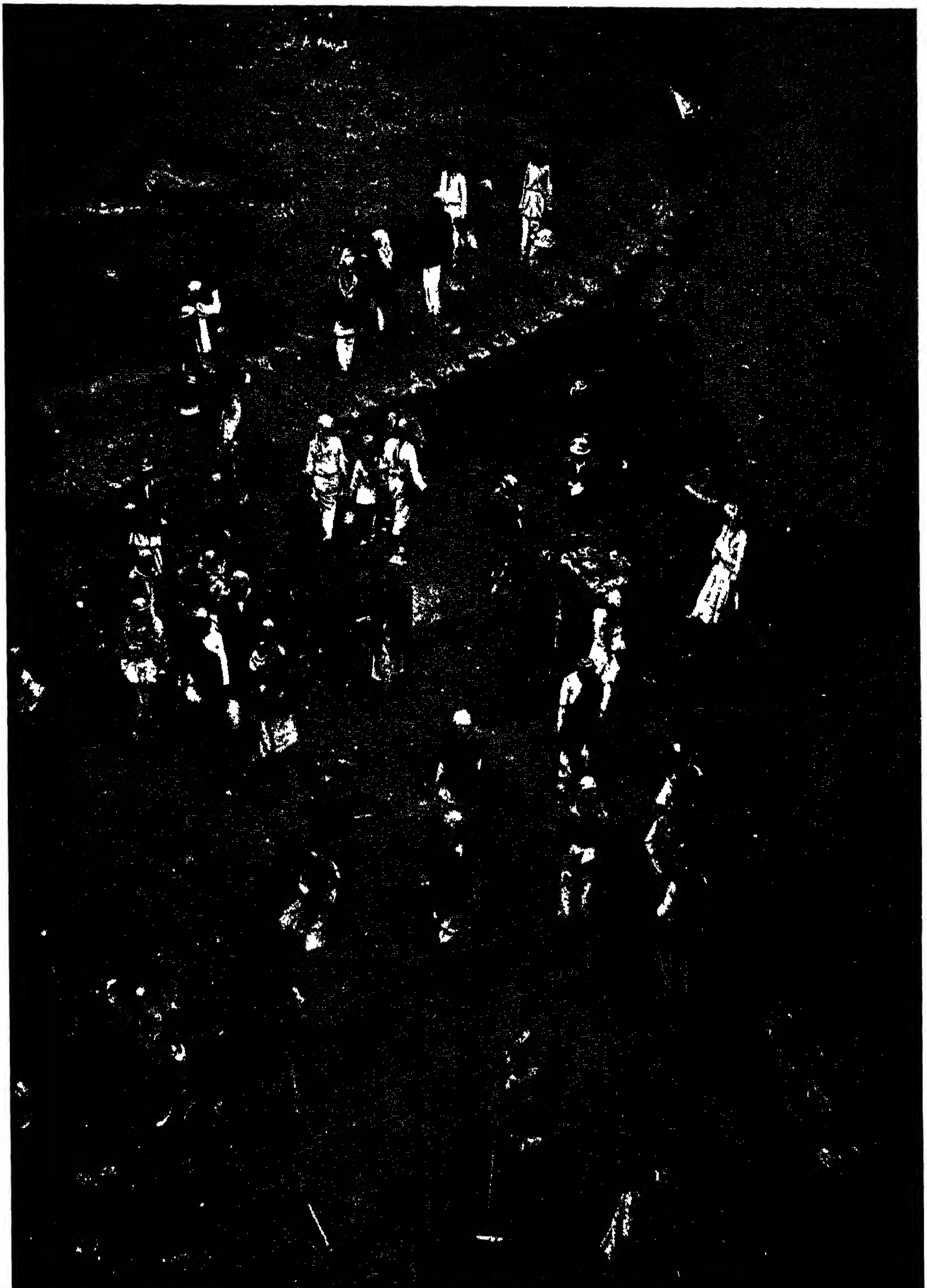
Two shafts were sunk beneath the Cemetery proper, as far as virgin soil. Here, again, the sequence of rubbish strata tallied well with finds in the pre-historic town, and there was the same gradual change from Diluvian to post-Diluvian wares. Though the treasures unearthed this season from the Cemetery were neither as brilliant nor as numerous as those of previous seasons, there was still a richness and variety of material. There was no lack of jewellery; beads and pendants of gold, silver, lapis lazuli, and carnelian. One coffin produced a splendid diadem of two gold chains supporting lapis lazuli and gold faceted beads, and an electrum dagger with a wooden handle, the pommel and hilt decorated with gold studs.

Although for scientific purposes we may consider that the main work of the Cemetery is at an end, it is obvious that there is still material to be extracted. A chance find may yet reveal a splendid treasure, but it seems highly improbable, and though here and there is still good unta ped ground, the rich veins have probably been exhausted, and such graves as remain to be found are those of straggling commoners, clustered on the outskirts of the main area.

The City Wall.

Towards the end of January, the gangs joined forces once more, and from then till the end of the season, there was a far-flung line of men, feverishly disencumbering the great city wall of the debris that concealed its traces. From the top of Ziggurrat, however, its main lines could still be discerned—a great ridge with the Temenos area at its northern end, shutting off the city proper from the low-lying desert around, and from a further series of high mounds on the north-east side, the untapped hills of lesser Ur.

The uninitiated may reasonably imagine that the work of excavating a great city wall is a simple process. It might be supposed that to dig out such a huge bulwark and to clear the face of the wall, was merely a matter of sheer physical labour. Nothing is further from the truth; for the constant denundation of the



(FIG. 1) WORKMEN EXCAVATING THE PREHISTORIC "KILN" LEVEL, BELOW WHICH LAY THE GREAT FLOOD BANK.

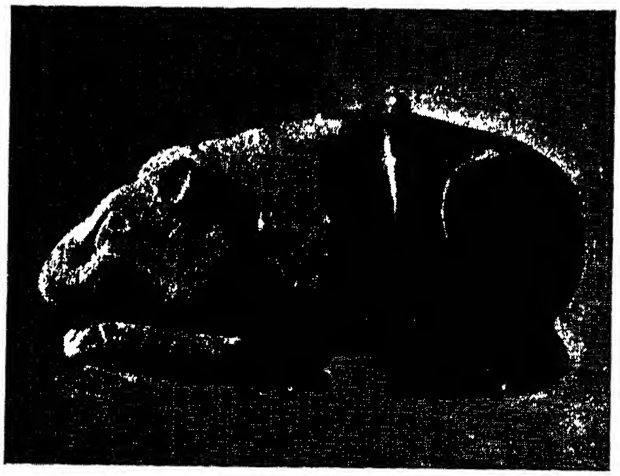


FIG 2

STONE SCULPTURE OF 4,000 B C.

Soapstone statuette of a boar, the earliest piece of stone sculpture in the round ever discovered in Mesopotamia.

ground made the task of discovering the frontage an exceedingly difficult business. Wind, rain, and the ravages of man had in many parts destroyed the original frontage, and it was often necessary to dig down to a great depth in order to uncover the wall face which remained only in its lowest level. And there was the further complication that as in antiquity itself the wall front was constantly being undermined by the action of water, the quay walls fell into disrepair, and it was necessary to build out additional quays to front the old. With the passage of time, therefore, the wall increased greatly in thickness, and often as many as three "kisus" were built on, one against the other, removing the canal line further out from the city itself.

As the walls were entirely washed by water (with the exception of some wall line at the north-west end) by the Euphrates apparently on the west side, and by canals on the remaining sides, the wall front was almost entirely built at a sharp batter or slope. Since the original face no longer remained, the wall mound had the appearance of a sharply sloping ridge running down from the higher level of the city to the low lying desert. Here and there were the remains of buildings of burnt brick; the private houses and temples that lay on top of the city wall itself; the difference of level between the floors of these houses and the foundation of the main rampart gave us the total height. The rampart varied in thickness from fifty to ninety feet, and was built entirely of mud brick which time had often fused together into a mass difficult to distinguish from the soil that encumbered it.

We have attempted to convey some of the difficulties of procedure in excavating the great wall. Let us consider the resulting picture, a picture not so much actually visible in the soil, though the evidence is all there to the expert, as deducible on paper. From the great foundations that have been so hardly dealt with by time, we can build up on paper the magnificent rampart that once was. And it is not to be thought of as a lofty wall, standing high above the plain, so much as a great barrage against the surrounding water impossible to undermine. The houses, temples, and forts, were built on top of this barrage, which served as a retaining wall for the higher ground of the city, often there was no visible inner face to the rampart, which lay flush with the higher ground of the city. In places where there was an inner face the houses were sometimes built out against the city wall itself. It appears that this great rampart was built by that Augustus of Ancient Ur, the great Ur Nammu, who flourished in about 2300 B.C., and crowned his building effort by the erection of the Ziggurrat in the heart of the city. The man-power that must have been expended on the erection of a wall of an average thickness of sixty feet, and a height of roughly twenty-six feet, for some two and a half miles, is staggering to contemplate.

The wall being entirely surrounded by water, it was necessary to construct two great harbours, one on the north and one on the west side of the city. Their area was large enough to shelter a great body of shipping, and they were protected from attack by narrow entrances, that of the west harbour was just wide enough to allow two ships to pass. All along the wall front was a quay about thirty feet in width, flanked by private houses built in burnt-brick. Such of these as remained were almost entirely of the Larsa period, *c.* 2000 B.C., similar in type to the Baghdad house of to-day, with a central court and rooms radiating off it. And as always in this period, the dead were buried in clay coffins beneath the house floors. A peculiar feature of the houses was that the doors were never on the quay front, but at the sides or facing the inner city, a feature that may still be observed on the town wall at Aleppo.

While the Euphrates flanked the west side of the city and canals the remaining side, there was also a great canal that bi-sected the inner town itself and issued from the northern harbour into the Euphrates on the west. Ancient Ur was therefore not only surrounded, but intersected by water, and the analogy with Venice will readily suggest itself.

Remarkable among the features of the wall were the numerous temples and fortifications that studded it at irregular intervals. One of these, built in the reign of Rim Sin, contained a remarkable foundation deposit (Fig. 3). Later kings often strengthened

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Beside the fortifications and temple strongholds that defended the city wall, there were everywhere the traces of the last occupants of Ur—the Persians. Their houses, the last to stand above ground in the

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TEMPLE FOUNDATION DEPOSIT, 1990 B C
This copper statuette of King Rim Sin, inscribed in cuneiform characters, enables the foundation of the temple to be dated exactly at 1990 B.C

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Extended burial as discovered in the Flood stratum, with offerings of painted pottery lying at the feet. In later periods, the bodies were slightly flexed

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The first traces of Ur in the island emerging from the marsh, the flood bank of the fifth millenium B.C., the great quay walls of the second millenium, and the miserable irrigation trench of the fifth century, all point a moral; that the measure of man's success in Southern Mesopotamia was his ability to cope with the water problem, a problem that taxed the resources of the ancient inhabitant no less than that of the living Arab to-day. Success brought with it great buildings, trade, and a profusion of the arts; failure, the misery and impotence that a merciless desert inflicts on him who would brave its torrid confines.

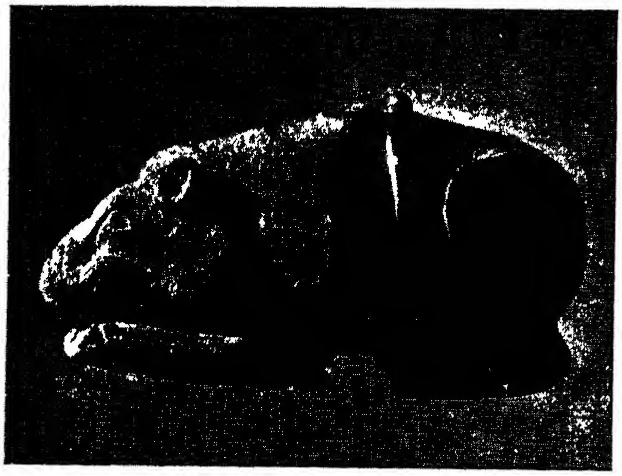

FIG 2

STONE SCULPTURE OF 4,000 B C

Soapstone statuette of a boar, the earliest piece of stone sculpture in the round ever discovered in Mesopotamia.

ground made the task of discovering the frontage an exceedingly difficult business. Wind, rain, and the ravages of man had in many parts destroyed the original frontage, and it was often necessary to dig down to a great depth in order to uncover the wall face which remained only in its lowest level. And there was the further complication that as in antiquity itself the wall front was constantly being undermined by the action of water, the quay walls fell into disrepair, and it was necessary to build out additional quays to front the old. With the passage of time, therefore, the wall increased greatly in thickness, and often as many as three "kisus" were built on, one against the other, removing the canal line further out from the city itself.

As the walls were entirely washed by water (with the exception of some wall line at the north-west end) by the Euphrates apparently on the west side, and by canals on the remaining sides, the wall front was almost entirely built at a sharp batter or slope. Since the original face no longer remained, the wall mound had the appearance of a sharply sloping ridge running down from the higher level of the city to the low lying desert. Here and there were the remains of buildings of burnt brick; the private houses and temples that lay on top of the city wall itself; the difference of level between the floors of these houses and the foundation of the main rampart gave us the total height. The rampart varied in thickness from fifty to ninety feet, and was built entirely of mud brick which time had often fused together into a mass difficult to distinguish from the soil that encumbered it.

We have attempted to convey some of the difficulties of procedure in excavating the great wall. Let us consider the resulting picture, a picture not so much actually visible in the soil, though the evidence is all there to the expert, as deducible on paper. From the great foundations that have been so hardly dealt with by time, we can build up on paper the magnificent rampart that once was. And it is not to be thought of as a lofty wall, standing high above the plain, so much as a great barrage against the surrounding water impossible to undermine. The houses, temples, and forts, were built on top of this barrage, which served as a retaining wall for the higher ground of the city, often there was no visible inner face to the rampart, which lay flush with the higher ground of the city. In places where there was an inner face the houses were sometimes built out against the city wall itself. It appears that this great rampart was built by that Augustus of Ancient Ur, the great Ur Nammu, who flourished in about 2300 B.C., and crowned his building effort by the erection of the Ziggurrat in the heart of the city. The man-power that must have been expended on the erection of a wall of an average thickness of sixty feet, and a height of roughly twenty-six feet, for some two and a half miles, is staggering to contemplate.

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FIG 4

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Extended burial as discovered in the Flood stratum, with offerings of painted pottery lying at the feet. In later periods, the bodies were slightly flexed

FIG 3

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Catching and Curing the Bombay Duck.

By James Hornell, F.L.S.

Late Director of Fisheries to the Government of Madras.

An ancient native industry is the subject of this article, which describes the production of a table delicacy much relished in India. The superstitions of the sailors provide an interesting field for study.

THE Bombay Duck does not sport feathers, as everyone is aware who knows anything about a real curry as opposed to the miserable counterfeit concoction of the untravelled European chef. It has a body encased in a sheath of delicate scales, and is indeed a fish, though to look at when it appears on the table to give relish to our curry, it has much the appearance of a fragment ripped off an Egyptian mummy !

Diu Island.

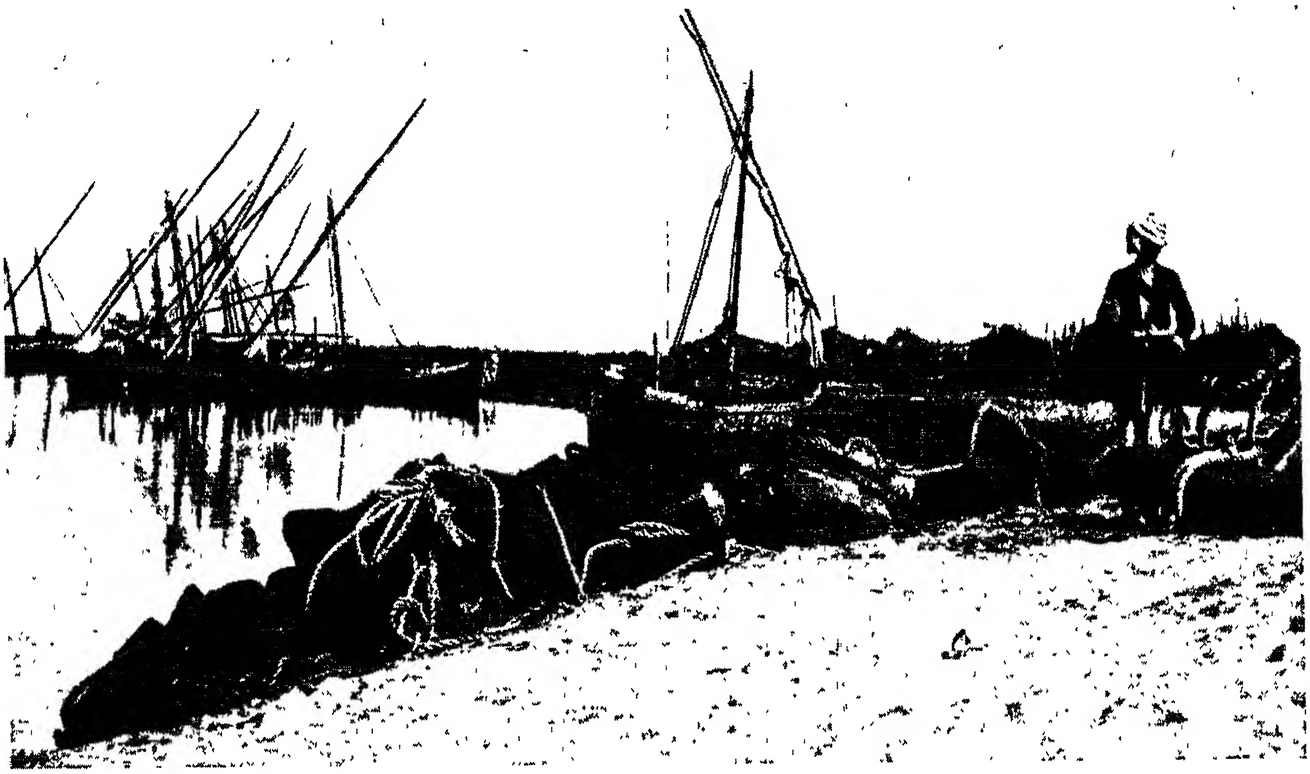
Few Europeans ever see it in the flesh or undergoing the primitive curing given it before being shipped to Bombay, the world's emporium for this delicacy. It is found in greatest abundance off the Gujarat and Bombay coasts, and more particularly off the wide and shallow entrance to the Gulf of Cambay. Diu Island, an important outpost of the Portuguese when they were the lords of the seas and coasts of India, is one of its greatest fishing centres; in the season, October till April, scores of large fishing boats from the Portuguese towns on the Gujarat coast go there to engage in the Bombay Duck fishery. These boats are trim weatherly craft, of about twenty tons register, built of teak throughout and intended primarily as cargo carriers. They are, indeed, the finest wooded vessels plying on the coasts of India; formerly their dimensions were much greater, the shiprights of Gujarat and Bombay frequently building boats up to one hundred tons and possessing skill adequate to the construction of much larger ones, now, alas! no longer required. It is worthy of remembrance that many a stately King's ship and stout East Indiaman was built in the Bombay naval yard, in the spacious days of John Company, by the same class of shipwrights as those few surviving in Gujarat.

In the construction of the smaller craft, with which we are here concerned, the planking is most ingeniously fastened together by a system of double tongue and groove jointing. The grooves and tongues are fashioned by the shipright by means of a curiously dumpy adze; he disdains the use of lines and gauges, depending entirely upon his eye as a guide. Before any plank is fitted permanently into position, the upper edge of the next lower strake is smeared first with a coating of red ochre and then with another of gum damar boiled in oil, over which is spread a thin layer of raw cotton.

In their rig these boats are single masted, hoisting the local form of lateen sail. Except for a short decking at each end, they are open, but when engaged in fishing the waist is decked over with a temporary flooring made of split bamboos. On this the men drowse and sleep during the hours when they lie to their net awaiting the turn of the tide. The crew of each boat numbers from seven to nine. By religion the majority are Hindus, by caste Machhis or fishermen, a community despised by high caste people, a condition which has been of the greatest assistance to the missionary in his efforts to convert this class to Christianity! They are decent, quiet folk, who put into everyday practice a simple form of communism. Among the crews there are neither masters nor servants; every man of them has his own appointed duty, and the produce of their common labour is shared equally among the men in each crew. Each man brings two bag-nets, together with the necessary gear of ropes, buoys, floats, etc. The owner of the boat, or the man who hires it on behalf of the venture, receives an equal share with the others as his remuneration. For this he has also to maintain the boat in perfect sailing order. So long as she is on the fishing station, all subsistence expenses, the cost of food and drink, and so forth, are defrayed from a common fund, the net profit being divided at the end of the season.

Sun-Scorched Fishermen.

The fishermen are a lithe, muscular, sun-scorched crowd. Burnt a dark shade of brown, exposure to sun and sea-spray dries their skin so thoroughly that it is no uncommon sight to see them make some simple calculation, perhaps a rough reckoning of the day's catch and its value, by scratching the figures on the skin of the thigh, a sliver of wood, or even the finger nail serving as the pencil. Figures so made stand out white and conspicuous, and are easily read upon the dark brown skin.



ANCHORING STONES USED FOR THE FISHING NETS

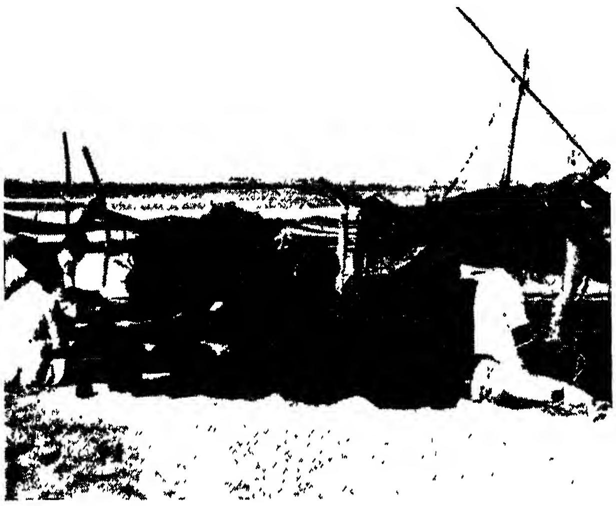
Where the water is too deep for stakes, piles of stones are used to anchor the nets, which are kept extended by bridles attached to the stones The cost of these stones is a heavy annual expense to the fishermen

The appliance used in fishing is an enormous bag-net. If the water be comparatively shallow, as off the Bombay coast, say up to eight fathoms, each net is secured by four short ropes to two huge posts driven into the sea bottom. The nets are conical in shape when extended; they average 150 feet in length with a circumference at the mouth of 250 feet. The meshes decrease gradually from four inches square at the mouth to half an inch or less at the cod end. To the latter is attached a seven-foot length of netting, which serves as a funnel for emptying the net into the boat after opening the cod end.

Off Diu, where the greatest catches are made, the water is so deep that stakes cannot be used, and the nets have to be extended by means of four long bridles attached to two piles of anchoring stones, placed about forty-five feet apart. Each pile consists of twenty great rectangular sandstone blocks, each about a hundredweight or more in weight, with a hole in the centre for the passage through of the stout ropes which tie them together. They are curiously made ropes, for each of the stout strands is made up of twisted leaflets of the date palm wrapped round with strips of the leaf of another palm, the palmyra, or toddy palm. When the piles of anchor stones are laid out at the beginning of the season, two palm leaf bridle ropes, about seven inches in circumference, are made fast at the lower ends to each pile of anchor stones. One of each pair of bridles, longer than its fellow, is buoyed by a large log of light wood, while a strong cord runs also from this buoy to the free end of the second rope.

To set the net, the ends of the four bridles are taken aboard and attached at equidistant points on the circle of the mouth; to keep it distended, a barrel float and two wood buoys float up the upper section of the net's mouth and serve also to locate its position. Nets are overhauled and emptied before the turn of the tide, either at the end of the flood or of the ebb, and reset at the beginning of the ensuing ebb or flood. One boat usually works several nets, either two or three when they are set to stone anchors, four, or even more, in the case of staked nets. In the traffic crowded waters in the vicinity of Bombay, these stake nets are a standing menace to shipping, and necessitate great care when navigating during the night. A strong tidal current is needed to maintain the nets in distended working order; during neap tides, from the 7th to the 11th, and from the 22nd to the 26th of each lunar month, the current being too slack for this purpose, the nets are detached and taken ashore for repair, and, when necessary, for barking.

At the end of the season the anchor ropes are cut away close to the stones and utilized the following season as lines on which to hang the fish while drying. The stones are too heavy to be removed, and so are



MENDING THE NETS
The nets used for catching the Bombay Duck are of conical shape, about 150 feet in length and having a circumference at the mouth of 250 feet.

lost to the fishermen at the end of each season. As the piles in use are fixtures and as the shoals cannot be counted upon with certainty to be found at one particular depth, each crew generally lay out anchor heaps of stones at two different depths, one at three to five miles from shore, the other six to eight miles seawards, according to the depth of the sea at the place they are fishing. The cost of these stones is a heavy annual expense Those who can employ timber stakes are under much heavier initial expenditure, but when once set up they last for years.

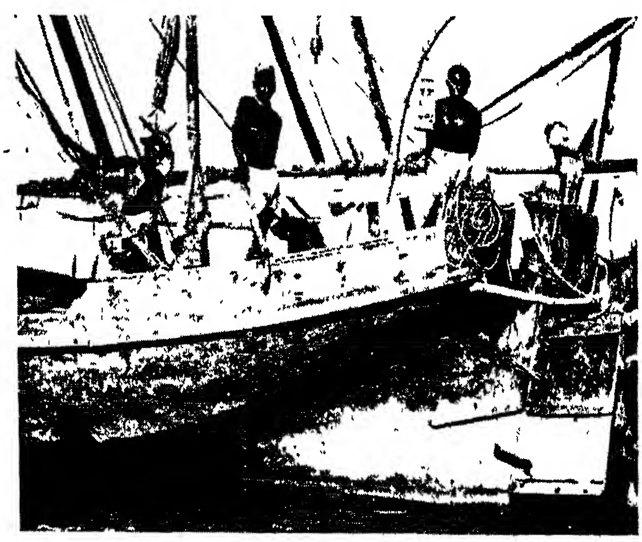
The *bumla*, as the Bombay Duck is called in the vernacular (its scientific name is *Harpodon nehereus*), is a gregarious fish, hunting for food in enormous shoals, the prey consisting of prawns and other small crustaceans. It runs from seven to nine inches in length; the body is slender, nearly cylindrical, pale and almost translucent in appearance when alive, its flesh soft and flaccid in consistence. Its voracity is vouched for by the great stretch of its jaws, armed with strong needle-like teeth, well fitted to seize and hold fast its prey.

If the bag nets happen to be set in such a way as to lie athwart the path of these shoals, huge catches are made, but alas! no care is taken to prevent damage to the fish and everything emptied from the net is slithered into the bottom of the boat; the little bumla, a few inches long, edy-higglpiggledy with giant bass weighing forty to fifty pound each. A second, and sometimes a third catch may at times be emptied on top of the first caught fish, and it may be even twenty hours before the boat returns to port, so eager are the men to catch everything possible when shoals are passing by in exceptional abundance. When this happens, the first lots become tainted and unfit for food long before they reach the shore.

No salt is ever used either afloat or ashore in the treatment of the bumla. Such as are deemed fit for curing—and the curer interprets this quality most liberally—are sorted into baskets by women and rinsed in sea water by the simple process of a deft rotation of the filled basket to and fro for a minute. To dry them, the fish are hung in pairs astride wornout and discarded anchor ropes stretched between upright poles, the under jaw of one thrust through that of the other, the long sharp teeth acting as retaining barbs. For market they are packed in large flat circular bundles, twenty-four to thirty inches in diameter, each containing 2,000 fishes. According to the size of the fish, so the bundles vary in thickness and diameter; thin fishes are said to be better flavoured and more delicate than the larger and thicker ones.

Pieces of old netting are used to secure the bundles which have no other covering, and are therefore exposed to contamination of all sorts. Much as the Bombay Duck is esteemed by Anglo-Indians (old-style !), it is questionable if it would be such a favourite were they to see the crudity and lack of cleanliness chacterizing its preparation. However, what the eye does not see, the heart does not grieve for, and it is as well to remember that only of recent years has the preparation of several items relished in our own cuisine been above suspicion.

Well prepared bumla in first-class condition is a deservedly esteemed savoury, but it scarcely merits comparison with the equivalent dainty so greatly relished in Northern France and the Channel Islands—

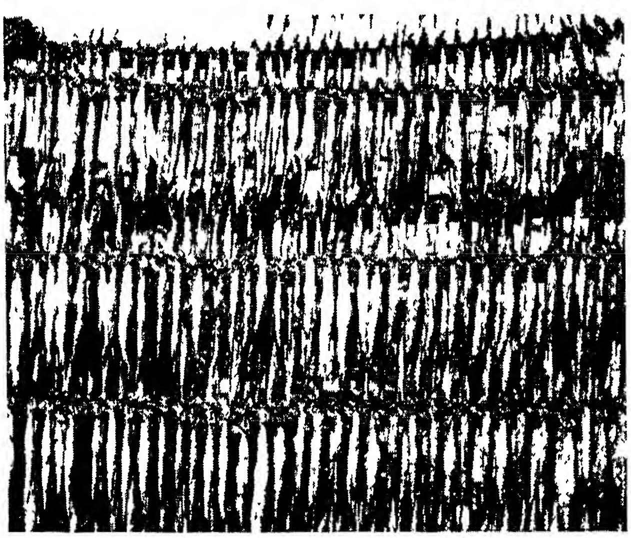


A TYPICAL CREW
The fishermen work on a communal basis, each member of the crew sharing equally in the proceeds of the catch. They belong to the Machhis caste.

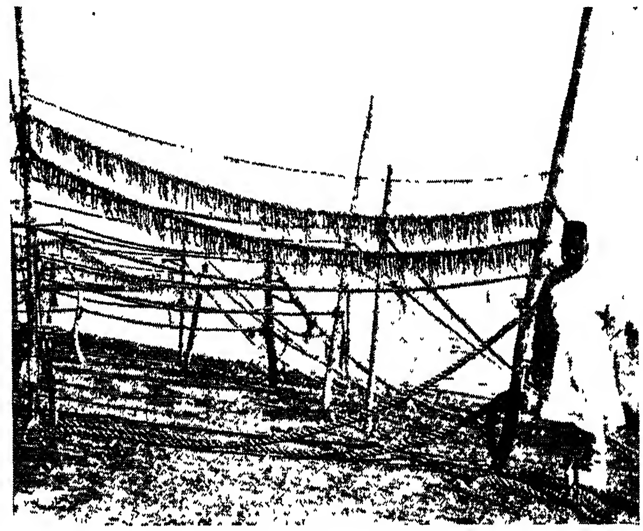
the toothsome *caplin* brought home from the Newfoundland banks by the cod-fishing fleet of picturesque sailing vessels, which hail from the northern ports of Brittany. Just as the immense shoals of caplin serve to attract multitudes of cod to the Newfoundland banks, so do the myriads of bumla serve as an attraction to the great *ghól*, the magnificent golden-mouthed Corvina (*Sciaena aquila*), which on the north-west coast of India follows the shoals of small fish into certain favoured bays. In exactly the same way it does so on the north-west coast of Africa, where, in Levrier Bay, under the lee of Cape Blanco, it is one of the greatest and most historic seasonal fisheries in the world—the annual resort for four months in the year of a great fleet of Spanish fishing schooners from the Canary Islands.

An interesting accessory industry of the Indian fishery, is the preparation of the swim-bladders of certain fishes, those of the ghól being the most valuable, for export as "fish-maws," the raw material from which isinglass is manufactured. These bladders, after being soaked in sea-water to wash off blood and dirt are dexterously ripped open in an ingeniously simple manner; a long, slender knife of razor-like sharpness is hinged at the top of a groove in a long tapered cone, upon which the bladder is drawn in the same way as a glove finger upon a digit. When laid open by levering the knife upwards, the vascular lining membrane is peeled off by hand, leaving the connective tissue wall of the bladder snowy white. Thereafter it is dried in the sun on horizontal sheets of cocoanut-cord netting raised on poles a few feet above the ground.

These Hindu fishermen are very superstitious, and sacrifice to local deities for success and safety at sea.



CURING THE "DUCK."
In order to hold the rows of fish together during the drying process, the jaw of one fish is thrust through that of another, the long sharp teeth acting as barbs.



THE DRYING APPARATUS.
The drying apparatus consists of anchor ropes stretched between poles For market the fish are packed in bundles, each containing 2,000 fishes.

The most celebrated shrine is that of Madhvar Devi, on a bold and dangerous headland near Diu. Here has been erected a tiny four-square shrine. The goddess is represented in low relief on an upright slab within. A little skirt of faded Manchester cloth is hung across the image, just above the waist; the rest of the figure is daubed thickly with many successive coatings of vermilion paint. The fishermen sacrifice goats and fowls before the shrine and lay small portions at the foot of the image, thereafter taking the offerings to their camp to eat! No accredited priest takes the simple service, which is carried through by one of the older men; the killing of the sacrificial animal, the sprinkling of its blood before the goddess, and the smearing of a little vermilion upon the deity's face is sufficient ceremonial. Such sacrifices are made at the beginning of the fishing season, and whenever a long spell of bad luck has been experienced.

In time of danger at sea, Hindu sailors and fishermen act precisely as do men of like profession in the Mediterranean; they vow an offering to the deity of their home shrine if their prayers for safety be answered. Those of one little port in South India when in danger of shipwreck take special precautions to impress on their protecting goddess the earnestness of their vow; they wrap a rupee, the usual offering, in a piece of cloth, and nail it to the mast. The superstitions of Indian seafaring folk are, indeed, a fruitful field for study; they believe as a rule in the evil eye, and mark their boat in diverse ways with a view to neutralizing the malignant influence. Most common, perhaps, is where, among orthodox Hindus, the symbol of the central deity of their cult is employed—the three horizontal bars denoting the worship of Siva being most in evidence.

Coal from the Air: A Chemist's Prophecy.

THE prophecy that coal gas would before long be obtained from the air was made by Dr. Herbert Levenstein, President of the Society of Chemical Industry, in an address at Birmingham last month. Referring to the wonderful development of dyestuffs as one of the greatest achievements of recent years, he said that a century ago the distillation of coal to produce gas must have seemed very unlikely to lead to a chemical industry. The smelly, crude gas was required for lighting. It had to be "scrubbed" if only because otherwise the tar was deposited in the pipes. This coal tar, a sticky black material, became interesting later, when it was found that it could be distilled and separated into pure organic chemicals, such as naphthalene, toluene, and above all, benzene. Then it was discovered how to turn benzene into new and more brilliant dyes, attractive perfumes, and popular drugs. To-day, however, it seems a dreadful weakness to have to use as raw materials for these industries the tar from those black, long-buried fossils, degraded celluloses, dead plants, and old forgotten forests. Æons passed before they could be used, yet the carbonic acid of the air is the sole source of the carbon contained in coal. The tree and plant know how to convert this acid into cellulose—the source of coal, coal gas and coal tar. Wind and rain, sun and soil—Aristotle's elements of earth, air, fire and water—are the raw materials of our organic chemical industries. A little sulphur they must have; a little of the halogens; some sodium and lime. The rest is derived from the growing plants or from the animals that live on plants. If we except mining and metallurgy, the various applications of metals and a few rocks and minerals, this is true of all our main industries. Above all, it is true of our very important raw material, Power.

"Living on Air."

It is becoming a matter no longer of choice, but of necessity, for the human race to learn to use the air, soil, and sun to the best advantage to make the earth more productive of food and raw material. This is one of the two great tasks of science. The other is how to decrease human suffering by the conquest of disease, which would follow slowly but surely upon an increased knowledge of the subtle chemistry of the living cell, of which so little is yet known. The discovery of how to use the nitrogen of the air to increase the productivity of the soil will remain one of the greatest landmarks in human achievement. But what a contrast there is between the high pressures and high temperatures of the huge plant at Billingham-on-Tees for the synthesis of ammonia, and the gentle methods of Nature in the roots of the leguminosæ. That is the characteristic difference between synthetic and natural methods.

Having tapped the inexhaustible supplies of atmospheric nitrogen, Dr. Levenstein continued, the next step is to transform another constituent of the air, carbonic acid, without the intervention of the plant, and thus to get, without the interval of a geological age, the raw materials now obtained from coal. The complete reduction of carbonic acid to methane (coal gas) has, in fact, been accomplished. It will certainly not be long before methane becomes a valuable raw material of the chemical industry. It could, in turn, be almost completely converted in the arc oven into acetylene, and acetylene could be polymerized to a tar about half of which consisted of benzene. Thus we obtain, by the synthetic, instead of the geological route, direct access to a new source of the products obtained from coal tar. Our available raw material would thus become inexhaustible

Passing of the Coal Age.

National wealth is reckoned in terms of coal or oil, that is, of energy stored up geological years ago. Dr. Levenstein said that the weakness of Great Britain as a manufacturing country is its dependence on fossil-wealth—that is, on coal—for power, instead of on the tides, the waterfalls, the wind, the direct radiation of the sun. Other countries are developing the use of water power for industries on a scale that seems stupendous compared with the small scale still predominant in this country. Power is being used in increasing amount per head of the population in all industrial countries, and much more rapidly in other countries than here. It is essential we should have the raw material, power, as cheaply as, if not more cheaply than, other nations. Another ten or fifteen generations would see the exhaustion of the world's principal coal deposits. The age of coal is passing. It will have lasted, when it is over, for a less period than the Moorish occupation of Spain, which at the time seemed so important to Christendom, and vanished leaving behind it nothing but a garden here and there, a palace or two preserved by the conqueror's pride, and a few romantic tales.

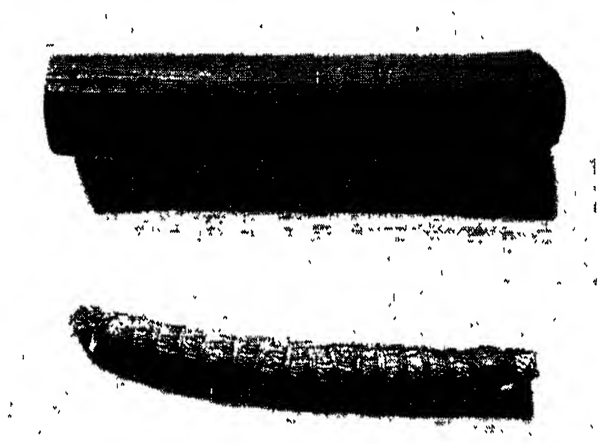
Medicine-Men and their Cures.

By Captain W. Hichens.

Late of the Native Administrative Service, East Africa.

Many discoveries in tropical medicine were anticipated long ago by the African medicine-men, whose methods are much more scientific than is commonly supposed. The author discusses the subject from first-hand observations, and shows how largely psychology is employed in the native cures.

By the new laws against witchcraft, passed recently in Swaziland, Kenya, Tanganyika, and elsewhere in British Africa, it becomes a penal offence for a native to practice as a witchdoctor. But it is interesting to note that they do not seek to suppress those wizened and rheumy-eyed old gentlemen to be found in the backveld kraals—the medicine-men. Though the two are often confused, there is a vast difference between the native witch-doctor and the native medicine-man. Where the witchdoctor deals in spells of evil, charms, and black magic, and is the familiar of ghosts and demons, the medicine-man, on the other hand, is the savage's medical man. His business is to prevent, detect, diagnose, and treat the diseases to which the savage and his animals are prone, and to deal with the wounds and accidents which are all too common in a country where wild beasts, snakes, thornbush, and such minor pests as scorpions, chigoe-fleas, tsetse, and tumbu flies abound.



NATIVE POISON BOTTLE

A poison-sachet used by the medicine-man to contain poisonous material is here shown, with (above) the bamboo tube in which the sachet is carried.

In the backveld kraals, where the white doctor may come out on *safari* not oftener, perhaps, than once a year, the *mganga* (as the native calls his medicine-man) is the surgeon, physician, neurological expert, herbalist, toxicologist, and veterinarian. His skill is one of the amazing factors of primitive savage life. For despite the popular notion that the lore and ritual of the savage medicine-man are no more nor less than the sheerest mumbo-jumbo, he is, in fact, an expert in his profession. In their own mysterious way, the secret clans of the medicine-men have discovered cures for diseases which still baffle white medical science. Indeed, they hit upon great scientific truths generations ago (and long before white men set foot in their tribal districts), which have only recently been hailed as among the triumphs of twentieth century scientific research.

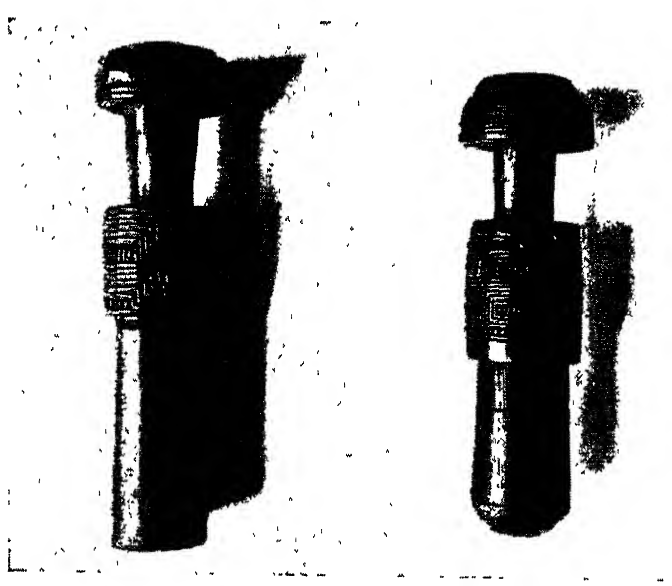
The great warrior and cattle ranching tribes of Kenya, the Masai, the Lumbwa, and the Nandi, knew long before the fact was discovered by veterinary research, that the redwater plague in cattle was caused by the bite of a grass-tick (*Ixodes spp.*). Their medicine-men gave it a distinctive name signifying "red-water," while their stockmen adopted preventive and curative measures very similar to those advocated by science to-day. The most practical of the native methods was the burning at suitable seasons of vast acres of dry pasture grass, when the fire destroyed the ticks and left behind it a broad trail of clean grazing The medicine-men devised *dawa* or "magic" medicine to cure redwater, and it is significant that with the Masai one of their tribal cattle cures includes urine (for ammonia), iron rust, and nux vomica, which are practically the three main ingredients of the cattle tonic now commended for the later stages of this plague.

The African savage also discovered of his own intuition that what the Kaffir calls *inapunga*, and the Boer *boschziekte* or bush-sickness—heartwater in sheep—was also caused by the bite of a tick, *Amblyomma hebraeum*; but, like the modern veterinarian, the native was baffled to find a cure for this scourge. He did what he could, however, in pasture burning, and attributed the high mortality in his flocks to the baleful intervention of the devil.

In *homa* or malaria, the great scourge of man in Africa, the savage medicine-man made even more

notable discoveries. He knew, generations before Sir Ronald Ross drove the fact home to our incredulous world of science of thirty years ago, not only that malaria is transmitted by the bite of the mosquito, but that the fever was caused by minute organisms and that the prophylactic for it was quinine. At the time when science was averring that malaria was caused by inhaling the gases from swamps and marshes, the old medicine-man, crouching over his steaming pots of herbs and roots, had linked that whining pest of the sunset, *mbu*, as the mosquito is called, with what the kraalsfolk would describe as a feeling like "millions and millions of tiny insects in one's blood." The savage, of course, had no conception of the malaria plasmodium as such, but he had puzzled out that there seemed to be "things" in his blood which made him writhe and itch with the fever. For want of a better word he called them *vidudu*, which means anything "insecty"; and, for want of a better word, not being certain how it really should be designated, our own bacteriology still refers to the malarial agent as a "parasite." But the savage linked the mosquito with malaria before that great fact occurred to the white man: some tribes even made *mbu* their totem.

The medicine-men were not baffled to devise a *dawa* for this insect-fever. They discovered the bark of a forest tree, shredded it, pounded and crushed it, infused it in water, slaughtered black goats to the gods to imbue it with magic, muttered incantations over it by the light of the full moon; mixed it with strange things, the blood of enemies slain in battle, the ground burned bones of lions, the crushed bodies of mosquitoes, the inflicters of ill: and this great medicine was strong, bitter and black to the taste—for it was quinine. What flash of genius (like the inspiration that urged Ross, Lister, and Pasteur) could have moved some half naked medicine-man, strung with his girdles of gourds and charms as he trod awesomely down some forest trail, to prize off with his raw iron knife the bark of the cinchona, we shall never know. Suffice it, that infusions of cinchona bark became the medicine-man's magic *dawa* for the insect-fever of *mbu*, the biter.



CARVED WOODEN BOTTLES

Another variety of medicine container, made of wood, used by the native doctors as receptacles for herbal powders. Notice the delicate carving on the corks and bottles.

But the medicine-man has many such medicines made from roots, bark, berries, leaves. One of the most striking is a fire-proof ointment used by the Akimbu snake-dancers in Tanganyika. These professional dancers travel from village to village, giving exhibitions of fantastic snake charming and of remarkable fire dances in which the performers seize blazing brands of wood and charcoal, bite fiery chunks from them, rubbing their faces, arms, chests, and legs with the flame and fire of the wood. But beforehand, while the crowd is gathering around their drummers who are announcing the performance, the dancers run off to a nearby belt of forest and gather the leaves of certain shrubs and trees. These they chew into a paste, and with this they mix *dawa*, a blackish powder which they have previously obtained from their medicine-man, whose secret it is. This concoction they then smear over their bodies, and, though they sit, roll, or dance in the blaze of the fire, they emerge unscathed, nor do the flaming brands make a mark upon their skins.

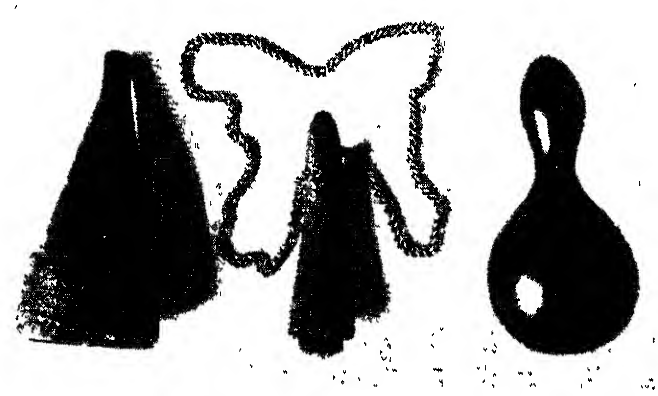
These people, also, have a singular antidote for snake poison. Not long back in the bush I came across one small Mkimbu boy sitting patiently beside another small boy, who was prone and apparently dead on the ground. Thonged and impotent in a forked stick by his side writhed a vicious puff-adder, which he had caught early that morning and which had bitten him. His companion told me that he had been lying so for some four hours, and I naturally thought his case was hopeless, but his companion was much amused at that. It was quite usual, he said, for them to be bitten by snakes which they caught for their elders, the snake-dancers, and the bitten lad had incised his wound with their medicine-man's *dawa*, and swallowed some of his powders in water, and in a few minutes he would be quite all right: and, in fact, within a short time he was. One of the Wakimbu medicine-men has informed me that this snake *dawa* contains snake-venom,

ground snakes' scales, and snakes' tongues as some of its ingredients, but what its other components were the old man would not divulge. Snake venom, of course, is one of our own anti-toxic treatments for snake-bite. The Wayeye, another clan of snake-dancers in Tanganyika, have also some thoroughly effective *dawa*, made by their medicine-men for snake-bite cure.

For the everyday ailments of the kraal, the medicine-man has an extensive pharmacopaeia of medicines, whose efficacy has not only been tested out over tribal generations, but is a matter of daily experience in the native village. One in common demand in the summer-time, when the beer-pots froth, perhaps a bit too enticingly, is a headache cure, *mtimburi imbwe*. This is made from nodules cut from the bark of a certain tree, ground down on a stone and mixed with water to form a paste, which is smeared over the forehead, and which, as I can testify, would appear to have definite anaesthetic properties. It certainly cures headache. Another mysterious medicine which has definitely tonic effects is *Tschichanyanja*, a root which the medicine-men will only collect from the forest on certain nights when porcupines are to be heard.

Despite the foul water and often tainted meat which natives sometimes eat, and the hordes of flies and often insanitary conditions, dysentery is not a very prevalent disease in the villages. But natives frequently contract it upon a journey to some neighbouring kraal, and they then have recourse to *manga nayaya*, a medicine made from tree roots. The roots are split longitudinally, and the fibres separated, and they are then tied together at both ends.

Perhaps one may find here an instance of symbolic magic, typifying the "fastening," as it were, of the alimentary canal. The tied fibres are soaked in hot water and the infusion is given as a medicine, to be taken in the quantities of half a pint three times a day for three days. The limit of three days is typical of the medicine-man's prescriptions, for he is not only confident of his cure, but he is definite as to when it will occur. Three, also, is a magic number.



MEDICINE SPRINKLER AND CHARM

On the left is a powder sprinkler from which doses of *dawa* are measured. Centre Charm-medicine, or herbs with pastes put into a dikdik horn as a talisman against rheumatism Right A small gourd, carried on the doctor's belt as receptacle for fluid medicines and powders

Another remedy made from tree roots is *Chiwanga*, which is applied as a paste to small incisions made in the scalp of sufferers from neuralgia. *Chipinda*, a similar medicine, is applied to incisions in the flesh on the ribs as a cure for bruised ribs: and numerous such medicines are in use to cure boils, abscesses, and skin eruptions. Mention must also be made of *milikila*, a remarkable tonic and partial anaesthetic given as a beverage to expectant mothers. Preparations of earth taken from the queen-chamber of termite hills are also used in the native's obstetric practice.

In addition to beneficent medicines, however, the *mganga* has naturally turned his attention to poisons, and most medicine-men are experts in the subtleties of toxicology. Some of the commonest poisons are prepared from roots, such as aconite. The medicine-man cannot be entirely absolved, perhaps, from aiding his satanic *confrère*, the witch-doctor, on the toxicological side. For there are a number of poisons which one may use to "remove" an enemy or a backbiting neighbour, by the simple means of sprinkling the growing corncobs in his grainplot with a subtle concoction, mixing tasteless powders with his food or beer, or even sprinkling tiny but remarkably vicious thorns, besmeared with poison, on his sleeping mat. Poisons for hunters are widely made, and are often so virile that the merest smear on an arrow or spear head will bring down a buffalo or an elephant within the span of sunrise to sundown. Such poisons are often done up in small sachets made of grass, cigar-shaped, and dexterously bound: and these are usually kept for safety's sake in small bamboo or hide cases.

The native medicine-man has ventured into experimental realms, and it is a remarkable fact that he discovered vaccination before Jenner was born, and innoculation against disease generations before Pasteur ever stabbed a culture. Working amongst the Iramba and Atatoga of Tanganyika I found that most of the kraalsfolk had been vaccinated by their medicine-men. Their method was crude: the *mganga*, getting news of a case of small-pox, would visit the patient, having first cloaked himself with a kind of

antiseptic "magic," and collect the excretions from the sufferer's pustules. This *dawa* he used as his primitive serum, inoculating it into rows of small slits cutting the skin of the foreheads or shoulders of those who came for treatment. In much the same way, witchdoctors "bewitch" their victims with leprosy: by collecting the pus and exudations from the bodies of lepers and inoculating by thorns and other insidious means set in the victim's path.

Just as the savage linked the mosquito and malaria, he saw the connexion between the hideous beanlike tick which lurks in the cracks of his mud-walled huts and the folds of his sleeping mats, and the plaguing recurrent fever. By what process of thought the medicine-man worked out that the bite of the spirillum tick (*Ornithodorus moubata*) could itself give immunity from spirillum fever is a mystery, unless we can find the solution in a kind of imitative magic working on the principle that ill defeats ill. Suffice it that in West and in parts of East Africa, natives in spirillum-tick infested districts carry pet ticks in small bamboo cases, and, when they feel an attack of fever is likely to become imminent, they let the ticks have a good feed on their arms and so acquire the requisite vaccinative infection.

The great achievement of the black medicine is perhaps in the psychological realm, for there can be no question that many medicine-men possess hypnotic and auto-suggestive powers of a high quality. Surrounded by witchcraft and all the terrors of superstition, and beset at every turn by omens and the machinations of the ghosts and spirits, the native is peculiarly susceptible to what psychology interprets as self-hypnosis and traumatisms, imaginary conditions of sickness and ill. It is by no means unusual for one native to visit a witchdoctor and fee him a goat to bewitch another native with, say, a splitting headache, a stiff arm, a lame leg, impotence, or even a spell of death. These spells work with such force of terror upon the native mind as not infrequently to bring about the exact condition of sickness or infirmity that the witchdoctor has decreed.

A Scientific Basis.

It is then that the medicine-man's skill is sought. His methods are often fantastic: he may boil a brew of herbs and cast magic stones, or hold a great drum dance to exorcise the devil of the ailment. He may even pretend to produce a live toad from the sufferer's liver, or a handful of nails, broken glass, and pangolin claws from his brains. But the essence of his cure is scientifically sound, for he quells the imaginary, self-hypnotic ailment by the overwhelming force of his own suggestivity. The *mganga* would not be an African were he not to surround his genuine cures with all the fantastic mumbo-jumbo of mystery and magic: but behind it all is a very real grasp of some of the main elements of medical science, and in matters psychological this grasp is often intense. Recently in Rhodesia a young witchdoctor, arguing with an old *mganga*, jeered at his elder's skill. "Ha!" said the old man, "were I to command it, you would drop dead!" "Huh!" sneered the youth, "try it!" In a very old voice the old *mganga* spoke the words, "Now you will die!" For a few seconds the youth stood, swaying, and then fell to the ground. A nearby white doctor certified that he had died of "heart failure." One need, perhaps, be no psychologist to link this heart failure with that dominant urge to die with which the old medicine-man imbued his death-command.

River Polution Problems.

FURTHER research into river pollution is among the objects stressed in a pamphlet just issued by the Fresh Water Biological Association. Far too little is known of fish diseases and the conditions which lead to their becoming epidemic in a river or lake. The importance of the problem is illustrated by "furunculosis," which affects salmon and trout rivers where it may cause great havoc among the fish. The disease is caused by a bacterium, which cannot survive in absolutely pure water but arises in water polluted by organic matter.

In combating a disease of this nature, obviously the best means is to control the pollution of the water. If pollution were prevented, then the disease might be expected to disappear. It is seldom, however, that pollution can be entirely prevented. It has been stated that the disease occurs more commonly in streams, the waters of which are acid, than in those which are neutral or slightly alkaline. If this fact were established, control of the disease might be effected to some extent by controlling the acidity of the water. On a large scale the only practicable method of doing this is to increase the aeration of the water, so that its carbon dioxide is given up to the air, and the acidity of the water thereby reduced. Increased aeration can be produced by constructing weirs over which the water is made to flow in a turbulent fashion so as to expose as much surface to the air as possible. Another method of decreasing the acidity of the water would be to increase the hardness by allowing it to flow over or through a bed of limestone or chalk.

The Detection of Gas in Mines.

By T. C. Crawhall, M.Sc.

Science Museum, South Kensington.

The design of an ideal lamp for miners has occupied inventors since the eighteenth century. The principle of Davy's safety lamp has recently been incorporated in a new type, which combines electric illumination with the "flame" detection that was the basis of the pioneer discovery.

In recent years a number of circumstances has compelled the general public to take rather more interest than formerly in the work of the miner and the danger of his occupation has been more fully realized. It is known that in most coal mines, and in a few metalliferous mines, great danger is caused by the presence of fire-damp, and other inflammable gases, which, in the presence of a flame, will cause an explosion, the effect of which may be very serious. It is natural, therefore, that many able men should have devoted their energies to the prevention of these explosions by the invention of suitable lamps.

Fire-Damp.

The chief of the dangerous gases, fire-damp, is composed of a mixture of gases, the principal being methane, or "marsh-gas." This gas is highly explosive if brought into contact with a flame. Its weight is only about one half that of air, and, for this reason, it is found in greater quantity near the roof of workings than at the floor level, except when it is diffused owing to a rapid current of air. The gas is trapped in cavities in the coal and is liberated when the coal is worked. Usually this liberation takes place at a slow rate, but should a large cavity be tapped the result may very well be disastrous. Fortunately this is a comparatively rare occurrence. The gas held in this manner is at a high pressure, and a pressure as high as 460 pounds per square inch, more than thirty times that of the atmosphere, was recorded by Sir Lindsay Wood in his famous experiments. Fire-damp is not poisonous, and, provided that there is a sufficient supply of oxygen present, it will have no serious effect on a human being, always provided, of course, that it is not ignited.

Carbon monoxide, sometimes known as "white-damp," is another dangerous gas found in mines. It is a deadly poison, and is produced by the incomplete combustion of carbon, and frequently follows an explosion. It may also be due to spontaneous heating of coal or to small local fires. Fortunately, the miner generally knows of these occurrences, and is therefore unlikely to be caught unawares. If the presence of carbon monoxide is suspected, a bird, usually a canary, is taken into the workings. In the presence of a small quantity of the gas the canary will be overcome, and this is the signal for the men to retire, unless they are equipped with a portable breathing apparatus. The bird revives immediately it is taken into a pure atmosphere, and suffers no ill effects. Following an explosion, when carbon monoxide is almost certain to be present, a rescue party, equipped with breathing apparatus, will go into the workings, and the leader will take one of these birds with him. In order that the bird may be revived as soon as possible, Dr. J. S. Haldane has invented a special cage, to which is attached a small cylinder of oxygen. Apart from this method of testing, the gas is generally difficult to detect, and, for this reason, it is particularly dangerous. The first effect on a human being is a quickening of the pulse and deeper breathing, and the victim is so quickly overcome that he may collapse before he is able to reach a more pure atmosphere.

These two gases are the most important of the dangerous gases found in mines, although others, such as "black-damp," a mixture of carbon dioxide and nitrogen, and sulphuretted hydrogen are frequently found in varying quantities.

The Steel Mill.

The use of artificial illumination in mines makes it imperative that there should be some simple means of detecting the presence of fire-damp. In order to show the close relationship between the methods of illumination and the detection of inflammable gas it will be necessary to trace briefly the history of the development of the lighting appliances used.

Before the commencement of the nineteenth century the "steel mill" was the only means of providing a light which was moderately safe in "gassy" mines. Fig. 1 is an illustration of such an appliance. The illumination was provided by the sparks produced by a flint held against a rapidly rotating steel disc. Apart from the very poor light obtained, this apparatus

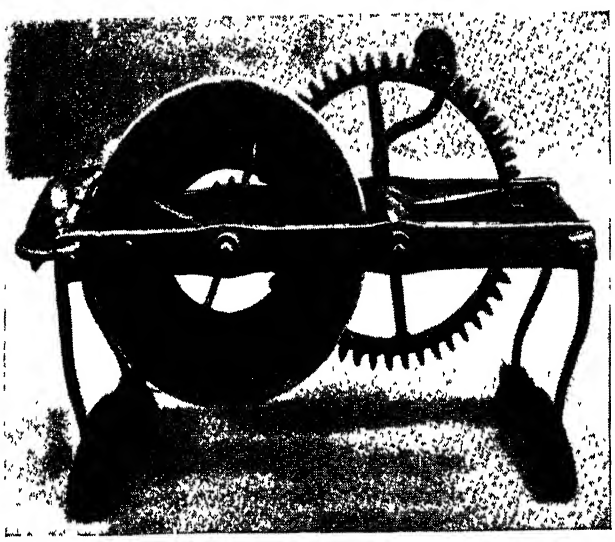


FIG. 1.
EIGHTEENTH CENTURY "STEEL MILL"
This pioneer safety appliance had the disadvantage of giving a very poor light and it required a boy to attend the miner to work it.

required a boy to operate it, and each hewer, or worker, was compelled to have this boy with him wherever he went. There is no doubt that in mines containing only a small percentage of inflammable gas the mill provided a moderate amount of safety, relying for this upon the low temperature of the sparks produced, and their small area. In "gassy" mines it was the cause of many serious accidents.

The very large number of explosions in the early part of the nineteenth century, with their attendant wide publicity, due to the increasing use of newspapers, had the good effect of producing serious investigation of the problem, and by the year 1815 Dr. Clanny, Sir Humphrey Davy, and George Stephenson had given the world the benefit of their research. The centenary of Sir Humphrey Davy has recently been celebrated, the most important function being held at Penzance, the town of his birth in 1778. He is well known as a scientist of great repute, and was a Fellow of the Royal Society. George Stephenson, on the other hand, was a working miner in Northumberland. His name is equally well remembered for his work in connexion with miners' lamps and with the early locomotives, particularly the "Rocket." Dr. Clanny, a medical practitioner of Sunderland, is not quite so well known, although he was experimenting with miners' lamps before both Stephenson and Davy. His early lamps were not a success, but later he was responsible for a very successful lamp which was similar in certain respects to the Davy Lamp.

It is supposed that Davy's attention was first drawn to the need of a safe lamp for use in mines by his visit to the Felling Colliery, in the County of Durham, after an explosion there on 25th May, 1812, in which ninety-two men lost their lives. A committee was formed in Sunderland, of which Dr. Clanny was a member, for the purpose of investigating the causes of accidents in mines, and Davy was invited to co-operate. Fig. 2 shows the two first Davy lamps actually used in a mine, which are now preserved in the Science Museum, with examples of other types illustrating the development of the safety-lamp.

It was found to be impossible to prevent the inflammable gases from reaching the flame, although attempts were made, chiefly by Dr. Clanny, to lead pure air from other parts of the mine, or from a container, but they were all without success. The invention of a lamp in which the flame was surrounded by a wire gauze was the solution of the problem. The inflammable gas which passes through the gauze causes the size of the flame to be increased, and the effect of the gauze is to dissipate the heat thus generated. Provided the quantity of the gas and the

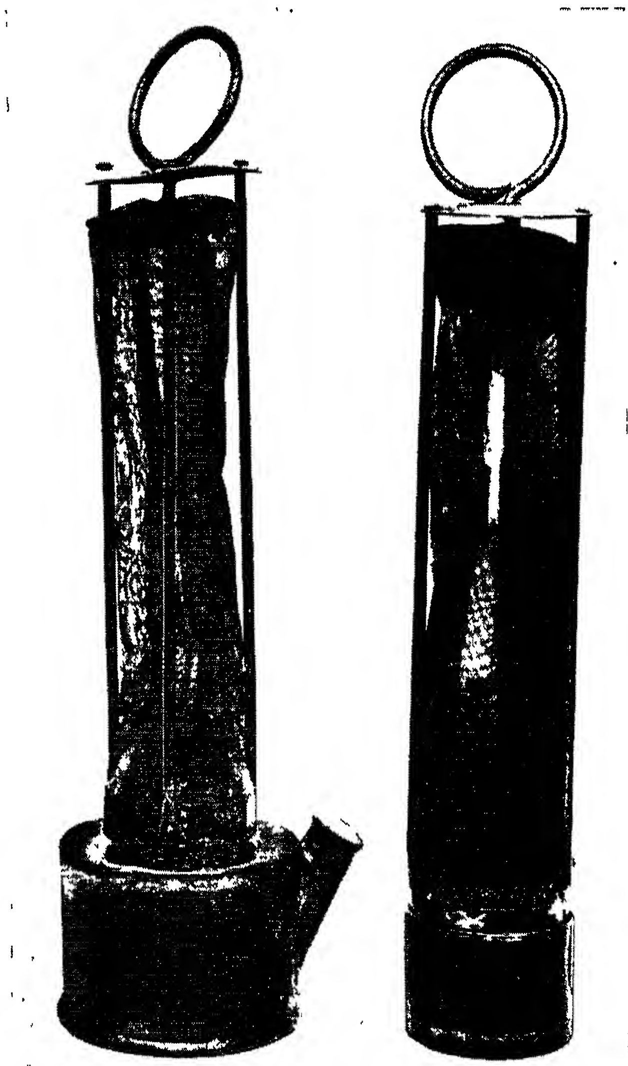


FIG. 2.
SIR HUMPHREY DAVY'S INVENTION.
The first successful safety lamps actually used in a mine. The principle of the gauze which Sir Humphrey Davy introduced has been used ever since.

speed of the air current are not too great, an explosion will be prevented. To demonstrate the action of the gauze, a simple laboratory experiment can be conducted. If a piece of gauze is lowered over the flame of a bunsen burner, the flame may be extinguished without passing through the gauze. In a similar manner, if a piece of gauze is held about one inch above the top of the burner, the gas may be lighted above the gauze, but the flame will not pass below.

The principle of the modern flame type of lamp does not differ materially from that of the early lamps, and from these remarks it will be seen that this form of lamp acts not only as an illuminant, but as an instrument for safeguarding the miner. In the words of Sir Humphrey Davy ". . . the applications of this discovery (the gauze lamp) will not only preserve him (the miner) from the fire-damp, but enable him to apply it to use, and to destroy it at the same time that it gives him a useful light."

Some further explanation of this method of detecting gas by means of a lamp is necessary. In the presence of fire-damp a pale blue "cap" appears on the top of the flame of the ordinary miners' lamp, and the miner is constantly on the look-out for this cap. Not only is this a warning, but it may also be used as a measure of the quantity of gas present. In order to do this it is necessary to lower the flame until only a small portion of the yellow flame remains (about one-eighth of an inch), and then in the hands of an experienced person the quantity of fire-damp may be fairly accurately determined, within the range of one to five per cent, by observing the height of the blue cap. Less than from three to four per cent cannot be determined with a full flame. The height of the cap will vary with the type of lamp, the size of wick, and the kind of oil used, but as it is usual to employ only one type of lamp with a standard wick throughout a mine, the amount of skill required to estimate the quantity of fire-damp is considerably reduced. Gas testing is carried out systematically by specially trained men, known as "firemen," who are able to detect the smaller quantities, while the miner himself is able to detect anything above about three per cent. More than five and a half per cent of fire-damp in an atmosphere forms an explosive mixture, although as little as one half per cent may be dangerous in the presence of coal dust.

Some very useful research has recently been conducted on the estimation of fire-damp by flame caps by the Safety in Mines Research Board. In the introduction to their report (Paper No. 37) the following passage appears :—"Many methods for the estimation of fire-damp have been suggested, but none, as yet, approaches the 'flame-cap' method for convenience and accuracy. Testing for gas, and estimation of the amount present, can be satisfactorily carried out with any well-designed flame safety-lamp. A lamp for illumination purposes is an essential part of every miner's equipment, so that the use of a flame safety-lamp for gas-testing does not add to the apparatus a miner is required to carry. The flame-lamp gives an automatic warning of the presence of fire-damp in dangerous quantity ; the manipulation required to obtain a close estimation of the quantity present, when the quantity is small, is not intricate ; and the indications are not masked by the presence of other mine gases, such as 'black-damp.'"

FIG. 3.
THE NEW SAFETY LAMP.
This combines the electric and flame type of lamps, giving the best illumination and a means of detecting dangerous gas in one compact apparatus. Working details are described in the text.

With the introduction of the electric hand lamp, the earliest of which was used in 1883, this very valuable feature of gas detection was lost, but, in spite of this, the number of electric lamps used in mines continues to increase. Their chief advantages over the flame

type are an increased power of illumination and a greater reliability. If it were not for the one great disadvantage that they will not indicate the presence of fire-damp there is no doubt that they would be universally employed.

The earliest lamps were fitted with primary batteries, and for this reason they were not a success. It was not until 1886, when Sir Joseph Swan invented a hand lamp which derived its current from a secondary battery, or accumulator as it is better known to-day, that the electric lamp was established for use in mines.

The natural development is obviously a combination of the electric and the flame types of lamps, which will give the best illumination, and which may be employed, at the same time, as an indicator of inflammable gas when this is suspected. There were many difficulties to be overcome, but such a lamp has now been placed on the market by Messrs. Ceag Ltd., of Barnsley. (See Fig. 3.) The current for the standard bulb is supplied by an accumulator, which is enclosed in the case of the lamp. Above the bulb is a small spirit lamp which may be lighted, when gas is suspected, by means of a coil of platinum wire fixed near the wick. The coil is connected to the accumulator, by which it can be heated sufficiently to light the wick. In order to test for gas the electric lamp is extinguished and the spirit lamp lighted. The percentage of fire-damp present may be estimated by means of the height of the cap on the flame, in the same manner as with the flame lamp. The spirit lamp has an advantage over the ordinary flame lamp, in which colza and paraffin oil are used, in that the height of the cap is greater for any given quantity of fire-damp.

In the lamp illustrated, the air necessary for combustion is obtained through the gauze in the top, which also prevents the passage of the flame to the outside atmosphere. The joints of the lamp must, of course, be gas-tight. The illuminating power of the electric lamp is not impaired by the spirit lamp, as the under surface of the spirit container acts as a reflector. A knob for adjusting the height of the flame and the switch for lighting the spirit lamp are conveniently situated on the top of the lamp, while the electric portion of the lamp is lighted or extinguished by holding the upper part firmly and rotating the lower case. To extinguish the flame after making a test it is only necessary to tilt the lamp.

Correspondence.

EMBRYOLOGY AND EVOLUTION.

To the Editor of DISCOVERY

SIR,

Mr de Beer, in a letter published in your July number, refers to a review of his book "Embryology and Evolution" which appeared in your issue of June, 1930. He also refers to a review of his book in the *Eugenics Review* published in April, 1930, which was also from my pen The latter review I do not propose to discuss, as it is no concern of your readers, but I should like only to make two remarks about it. It was most improperly shown to Mr. de Beer before publication by the Editor of the *Eugenics Review*, who also printed an abusive letter by Mr. de Beer in reply to it *in the same issue* I am in a position to state that effectual steps will be taken by the Council of the Eugenics Society, who control that publication, to prevent any such breach of journalistic etiquette on the part of the Editor in the future, and that a letter from me in answer to Mr. de Beer will appear in its next issue

The answer to Mr. de Beer's conundrum is very easy, and the fundamental fallacy is his, not mine. He asks by what right I assume that when the young forms of a group conform to a type, and when this type is also shown by the young forms of its aberrant members I assume that the common ancestor showed that type in *adult* life The answer is that the *type* of structure referred to is shown not only by the youthful forms of the vast majority of the members of the group, but is retained by them *all through life* until the completion of their growth and the attainment of the completely adult condition. When the aberrant members of a group show the typical structure in their younger stages and afterwards lose it, the sensible conclusion drawn by all comparative embryologists (except Mr de Beer) is that their ancestors retained it throughout life

Finally, I refer Mr. de Beer to the works of Eimer, who, as a result of a lifetime spent in the study of systematic zoology, arrived at the conclusion that new characters appear *at the end of growth* (*i.e*, in the adult condition)

Yours truly,

43 Elm Park Gardens, S W.10. E. W. MACBRIDE.

"UNWANTED ANIMALS."

To the Editor of DISCOVERY.

SIR,

I was very interested in the article on nature becoming unbalanced, in the last number of *Discovery* that reached me.

Owing to the destruction of the dingo and the provision of water in the arid districts, the kangaroos are a most serious trouble To give an example. On a station where the owners are giving fourpence per head for kangaroos, and the skins are worth something besides, a paddock of about 16,000 acres (which would carry sheep at the rate of about one sheep to twenty acres), was raided by these animals. The kangaroos drank between 2,000 and 2,500 gallons from the trough, *i.e.*, presumption that there were at least 2,000 kangaroos in the paddock All the other paddocks suffered the same. To you no doubt twenty acres to a sheep is very poor carrying capacity, but you must remember that in the pastoral districts the season is uncertain, and consequently one has to stock if not for the worst, for at any rate a poor season

Yours truly,

Queen's Park, Western Australia. CLAUDE L. PIESSE.

The Problem of Pain in Animals.

By D. F. Fraser-Harris, M.D., D.Sc., F.R.S.E.

A comparison of the nervous system in human beings and animals suggests that there is the greatest amount of popular misconception about pain. The author shows how pity is often misplaced, whereas intense pain may be caused to animals by apparently harmless factors.

PAIN may be defined as a disagreeable kind of sensation which we instinctively desire to terminate. We distinguish bodily from mental pain, the pain of toothache from the pain of parting. Confining our attention first to human beings, we may say that all sensations have their seat in the brain, that if the grey matter of the brain is not in a state of activity, neither sensations nor pain can be perceived. Thus, while we are asleep or while the brain is under the influence of a drug, a so-called narcotic, we do not feel pain, because for the time being the grey matter of the brain is out of action. Shakespeare was quite right when he said: " He that sleeps feels not the toothache."

No Brain, No Pain.

Now just as we have no sensation in any part, say of the skin, if all the sensory nerves of that part have been severed, so neither can we have any pain. Hence in one form of leprosy, a disease in which the nerves of the fingers are destroyed, the patient feels no pain in these fingers. To perceive pain we must have at least a nerve and a specialized part of the brain related to it : no brain, no pain. It would therefore seem extremely probable that all those animals we call "invertebrate" which have no brains—jelly-fishes, worms, oysters, lobsters, etc.—feel no pain. We cannot dogmatize in the circumstances, but that would be the natural conclusion to come to.

Sensory nerves must have their origins somewhere—for instance, in the skin, or in the inside of a tooth—and we know that if the pulp of the tooth is exposed and some food or cold water has got into it, we shall suffer a certain amount of pain. In other words, the unusual, " unnatural," stimulation of the nerve-endings (really sensory nerve-origins) is a source of pain, but that pain will not be developed unless, in addition, a conductor (a nerve) is present and a brain-centre is also in activity. Physiologists divide pains first of all into two great classes, those due to the irritation of sensory nerves, and those due to the irritation of nerves of " pure " pain. Let us look for a little at the former of these.

When the ordinary sensory nerves, say in the skin, tooth, eye, or tongue are irritated or " stimulated " in some unusual manner, pain is the result. Thus the pain of a corn is in this first class, for the sharp core of the corn stabs a sensory nerve of the skin just as effectually as though a needle had been run into the nerve from outside. Here we have an ordinary nerve stimulated in an extraordinary manner. All tearing, bruising, compressing, etc , of the sensory nerves gives rise to pain, because these are all unusual, abnormal stimulations of the nerves, the result of which in consciousness is pain. A naked nerve is not intended to come into contact with the outer world; if it does, as in an exposed blister, the result is painful. Even a breath of air is painful to an open blister. Another variety of pain in the first species is pain due to the excessive stimulation of a sensory nerve. This is perhaps the commonest cause of pain. A warm drink is pleasant to swallow, but boiling water is excrutiatingly painful. A slight pressure on the skin is endurable, to have the nails squeezed in the thumbscrews is torture.

The Internal Organs.

The second great class of pains is that in which the irritation is applied to a nerve of " pure "·pain. By this we mean a nerve whose exclusive function is to convey impulses of such a kind as give rise to pain. Fortunately some of these may rarely or never be in activity. The bodies of animals seem to be provided with nerves that normally give rise to no sensations at all, and which, therefore, may never come into activity once in a life-time, but which when stimulated produce only painful sensations. Most of the internal organs—heart, stomach, intestines, gall-bladder—possess such nerves. With them it is pain or nothing.

In perfect health we have no sensations from the heart, but when something has gone wrong with this organ, as in angina pectoris, the patient experiences the most terrible agony. Similarly, in the case of the eye, the iris has no nerves of ordinary sensation, we are not aware of its presence. But if the iris becomes inflamed (iritis), we then experience a very painful condition in the interior of the eye. Ordinary

sensations from the cornea or "window" of the eye-ball are very vague and feeble; we are not really aware of the presence of the cornea until a grain of sand gets between it and the eyelid, when we feel it distinctly painful. And so it is with all the internal organs; they have no nerves which inform us of their condition in perfect health; not to know we have a stomach is to have a perfect digestion But as soon as we have an attack of indigestion, the nerves of "pure pain" in the stomach make us disagreeably aware that all is not well.

Abolishing Pain.

Mankind, however, is more interested in getting rid of pain than in analysing it. There is more than one way, because the path from the surface or from the interior of the body to the brain is relatively a long one. There are, in fact, four places where pain may be abolished—at the place of origin of the sensory nerve-fibres (periphery); in the nerve-trunk, in the spinal cord, and lastly in the brain itself. We abolish pain of peripheral origin when we paint cocaine over the tonsils before cutting them out, or freeze the gum before drawing a tooth. Here we are putting out of action the microscopically small beginnings of the sensory nerve. A frozen finger, nose or ear feels nothing because the sensory nerve-origins being frozen will not conduct impulses. They do not permit any impulses to be even started on their way to the brain, therefore the brain feels nothing because there is nothing to feel. This is alluded to as "local anaesthesia."

In the second place, one may interrupt the conduction in the nerve-trunk, as when the nerve is cut, pressed upon or frozen so as to destroy its conductivity. Pain-bearing impulses may also be interrupted in the spinal cord. This is what the surgeon accomplishes when he operates under "spinal anaesthesia." In this case he allows a drug to influence the spinal cord in such a way that, for the time being, the cord will not conduct impulses upwards or downwards. He then may cut out the appendix or amputate a leg without the patient perceiving any pain. Here there is no pain because the pain-bearing impulses, being blocked in the spinal cord, never reach the brain. Lastly, we can abolish pain by rendering the brain itself—the percipient centres—inactive. This is called "general anaesthesia" because when the brain is thus put to sleep artificially by chloroform, ether, nitrous oxide or other "anaesthetic," all sensations from the body are abolished. Chloroform not only makes human beings and animals insensitive to pain, it also blocks out these algesic impulses which are so injurious to the body and so prone to lower the sufferer's vitality or resistance.

It is physiologically proper that pain be prevented as much as possible, because it is certainly injurious to the body if at all long continued. In the case of persons tortured on the rack for example, such profound neural fatigue was induced that the victims often fell asleep sometime before they died

We are now in a position to understand something about the nature of pain in the lower animals. The first fact that must be grasped is that reflex actions, reflex struggling, writhing, or convulsions are in themselves no evidence whatever that pain is being experienced. After an animal has been decapitated or had only its brain destroyed ("pithed"), its spinal cord is still capable of carrying out most powerful and complicated reflex actions, so that the now brainless "animal" may kick, jerk, writhe and even scream without a scintilla of consciousness being present. This is such a fundamental fact in neural physiology, that it must be grasped beyond all possible ambiguity. Not to understand it is to introduce endless confusion into the subject of animal pain.

Some Experiments.

The typical experiment is done on the cold-blooded frog, which can be instantly decapitated by a pair of scissors, and so leave the body and limbs in such a condition that they will live for many hours. The reason for this is that the heart continues to beat long after the head is removed. This headless "preparation" is absolutely destitute of sensation, emotion or volition. It can be hung from a hook, and will remain motionless until it dies by drying up. The spinal cord is alive but in the absence of the brain has no spontaneity, no sensation, and therefore no pain: no brain, no pain. If now, instead of allowing it to dry up, we keep it moist, we can discover some interesting capabilities of this "spinal frog."

If we touch a toe, the foot and leg of that side will be drawn up not by any act of will on the part of the brainless preparation, but by a purely muscular reflex action. This kind of reflex action, which is not accompanied by consciousness, is known as "excito-motor." If we place a piece of acidulated blotting paper on one flank, the corresponding leg will be drawn up and flick away the paper with a dexterity and precision worthy of the fullest consciousness. Further, if we hold down this leg, the *other* leg will eventually be brought up instead and flick away the paper. It *looks like* the most determined intention; it is nothing of the kind, for this spinal frog has no mentality whatever, and will hang from the hook

till it becomes a mummy. Similarly, a headless snake will wind itself round a red hot poker—no conscious animal would do that.

The "spinal" frog will originate nothing and never make an effort to get free. It is no longer "a frog," it is an amphibian reflex mechanism. A headless frog is not a dead frog, but only a living, reflex, spinal apparatus. It is a spinal cord still actuating an unconscious body. If we deliver to this headless trunk a series of rapid electric shocks, we shall throw the whole body and limbs into violent convulsions which are no sign of sensations or of pain. All decapitated animals are capable of movements which *look* extremely like those of conscious life, but are not. The decapitated hen or duck, which rushes round the farm-yard, has certainly, for the time being, life, but its muscular commotions are not the sign of conscious life. These decapitated birds having no brain, have no pain; even the kitchen-maids know that amount of physiology.

The brain, however, may be present and yet may not be performing its functions, one of which is to perceive pain. It may, for instance, have become extremely anaemic (exsanguinated) as in the case of an animal whose throat has been cut. In the Jewish method of slaughtering an animal, all the four great blood-vessels in the neck are severed by one sweep of a long knife, so that the animal, rapidly losing much blood, becomes insensible and falls to the ground struggling. These struggles betoken no consciousness, no pain, they are indicative of no "death agony" however much they look like it, they are the last convulsions of muscles about to die. These muscles are in convulsions because the dying (but not dead) spinal cord is sending to them their last impulses. These convulsions are the last signs of life, but it is life without consciousness. There is *com*motion, but no *e*motion. The Jewish method of slaughter is, thus, a humane method, for in a second or two the exsanguinated brain is insensible.

Animal Injuries.

In themselves, then, writhing, wriggling, squirming and all these sorts of muscular spasms are no evidence of a suffering creature. On this subject there is the greatest possible amount of popular misconception.

Another factor affecting pain in the lower animals is richness of sensory nerve-supply. We have every reason to believe that, region for region, the nerve-supply (innervation) in the lower animals is not so abundant as it is in man. Thus the lower animals are able to get about with wounds and injuries of such a kind that similar ones in man would cause agony if not fainting We ought not to interpret animals' discomforts in terms of human sensitiveness.

A dog will hop along on its three legs with the broken fourth leg dangling in a fashion which is not comparable with human behaviour. It is doubtless suffering to some degree, but to imagine that it is suffering to the extent of a man with a similar injury is to misinterpret the whole affair. A horse which has just fallen down and cut its knees will certainly stand trembling for some time after the accident, but only by the greatest stretch of the imagination can we maintain that it is suffering to the same extent as a man would do in similar circumstances. A fish that has had a hook in its gills, will return very shortly afterwards to the same hook. Animals caught in traps and snares—odious and cruel as these things are—struggle vehemently to be free, but once they are free, they do not seem to be very much disturbed by their wounds. After a little licking of the part, they resume their former mode of life as though nothing very serious had happened.

The Skin.

The next thing we should understand is that in the healthy animal, the *skin* is the tissue in which resides the maximum potentiality of pain. In simpler language, to cut, tear, pierce or crush the skin is very much more painful than to insult similarly any other healthy tissue. We must emphasize "healthy," because an inflamed internal organ can be exquisitely painful. For the moment, we are considering only the healthy normal animal. The reason for this difference between the pain-possessing powers of the skin and those of all other organs, consists in the much greater number of sensory nerves in the skin as compared with all other regions. The internal organs, in fact, possess no nerves of "ordinary" sensation in the sense that the skin does. But they do possess nerves of "pure" pain which, as we have seen, are not brought into activity unless and until the part becomes inflamed or diseased. This is a point not readily grasped by those who have not studied the subject of nerve-supply. In perfect health, it is obvious that the states of the internal organs are almost entirely outside our consciousness. The movements of the heart, of the intestines, of the gall-bladder, of the blood in the nerve-sheaths, etc., are, *in health*, entirely unperceived. The older way of putting this was to say that these internal organs had "vegetative life" which was sharply contrasted with the conscious life of the rest of the organism.

Consider the case of a healthy animal or human being in whom we have cut through the skin and are

handling the internal organs. Curious as it may seem, the handling of the healthy heart, stomach, intestine, liver or kidney not only arouses no pain, but is scarcely perceptible. Only very rarely nowadays can an observation of this kind be made because both animal and human being would, in these circumstances, be under the influence of an anaesthetic. But such observations have been made. The classical case is that related by the great William Harvey himself, how he took King Charles I to see a patient whose heart was (congenitally) exposed. Harvey tells us distinctly that unless the young man *saw* them touching his heart, he was completely unaware of it.

Any surgeon will assure us that the brain itself is insensitive to contact or cutting. Similarly, as regards the writhing intestines, they are always "writhing," which is only another word for the more technical "peristalsis." Those who misunderstand or misrepresent these things, assume that because the intestines are "writhing" they are *therefore* painful—there never was worse physiology. The intestines are "writhing" all the time, and although we do not see them they are moving "for all that" (painlessly). They still move painlessly when we open the abdomen and inspect them. A story used to be current in the Glasgow medical school that during an abdominal operation, the patient came out of the chloroform too soon and placidly watched the surgeon handling the coils of intestine. The exposure of an uninflamed organ is painless. It is the surface of the body—the skin—that is pre-eminently painful. As soon, however, as the internal organs are inflamed they do become extremely painful. The inflamed peritoneum, inflamed bone, inflamed nerve (sciatica) are all agonizing.

It is because the pain originates in the skin that we always anaesthetize an animal before cutting the skin. The puncture of an animal's skin by a hypodermic needle is a mere momentary inconvenience; many animals continue to eat unconcernedly while blood is being drawn off from their veins, because veins have no sensation.

Mental Pain.

When, on the other hand, we consider the *mental* side, we soon discover that this is the really distressing thing for a lower animal. A horse which is making very little fuss over its cut knees, will leap back in terror at some unfamiliar object. A dog enjoys fighting, and when once he has got his enemy's fangs out of his neck, he does not worry any more on that account; but he will bay in distress at the full moon as at some strange and sinister eye gazing fixedly at him. The dog which hops about unconcernedly with that broken leg, will howl with alarm at some sudden and unusual sight or sound.

The mind of an animal, like that of a child, is so limited that anything it has never seen before is strange to it, and anything which an animal cannot at once understand may throw it into a state of terror. It is the unknown and the unexpected that animals cannot abide. The dog surprised and alarmed will bite even his beloved master. Animals suddenly startled can be reduced to a condition of extreme agitation. The fear of the unknown, the unfamiliar, is enough to throw many animals into a state bordering on madness. The incomprehensible is to them the detestable. The sense of impending ill makes animals supremely uncomfortable and highly irritable. This statement is in perfect accord with that of Professor Dodds, that laboratory animals have no "apprehension." What he meant is that as the animals have no means of knowing what is in store for them, say an operation, they do not suffer that type of mental pain which the apprehensive human being suffers while waiting for an operation. A man knows that an ordeal is before him, the animal has no means of knowing anything of the kind. This is what Dr. Dodds very properly emphasized.

Cruelty of Hunting.

But once an animal is able to suspect that some harm is intended to it, if it is roughly seized or hunted by its natural enemies, then its agitation is extreme. The panic of the hunted hare, fox or stag is pitiable. I have often made my students observe how that if you merely catch hold of a rabbit and lay it down gently on its back, preparatory to giving it chloroform, it will scream in such a fashion that anyone not in the room, and therefore not seeing what was going on, would certainly conclude that the animal was being tortured.

We are, in brief, too apt to overlook or minimize the painful *mental* side of an animal's life. Animals can certainly suffer from mental anguish; they suffer as children suffer who cannot comprehend what is about to happen to them, for both animals and children dread the unfamiliar and mysterious. Animals can be disappointed as truly as human beings can, and they know when they are being cheated, frustrated, circumvented. Their powerlessness makes them afraid and irritable. Animals can suffer grief, inconsolable grief, ending in death by starvation. The story of "Greyfriar's Bobby" is no isolated myth; even a dog has been "faithful unto death."

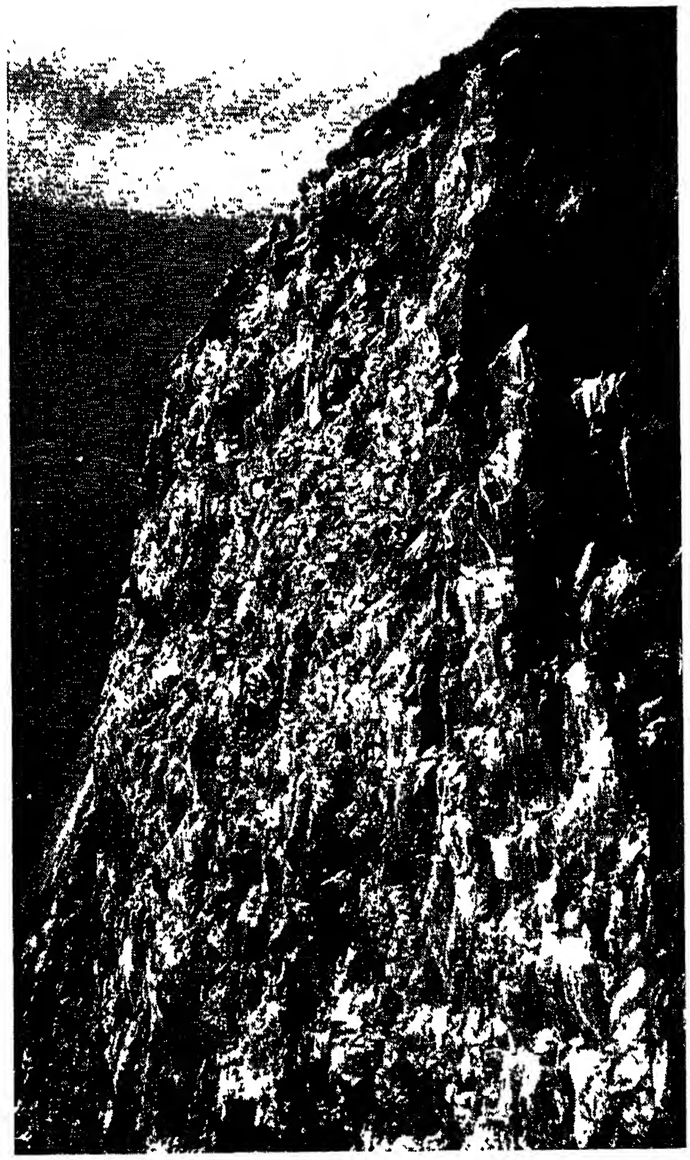
The Habits of the Gannet.

By M. G. S. Best.

The Gannet is one of the most picturesque of British sea birds, but little is known of its habits as it is seldom seen inland. Miss Best recently paid a visit to the island of Grasholm, which is inhabited by a large colony of Gannets, and here describes her observations.

THE Gannet, or Solon Goose (*Sula bassana*), with his snowy white plumage and his long black-tipped wings which boast a stretch of 5½ feet, is certainly one of the most notable of all our British sea-birds. It is a joy to watch him on a summer's day, flying slowly overhead, high above the water, intent upon his fishing. Suddenly he will pause in his flight, hang in the air for a brief second, then, with half-folded wings, hurl himself almost perpendicularly into the sea, disappearing from sight in a big splash of water.

Fishermen say the birds have been caught in nets sunk to a depth of 180 feet; their dive must have carried them to that depth, as they do not swim under water. When a fish has been caught, the gannet will generally sit on the water and swallow it at his leisure, but if he has missed his catch he soars upward again and continues fishing. The fishing seems to be a continuous performance whatever happens, only, when the dive has been successful, there is a slight pause before he begins again.



NESTING ON THE BASS ROCK
On these narrow, wind-swept ledges thousands of gannets build their nests.

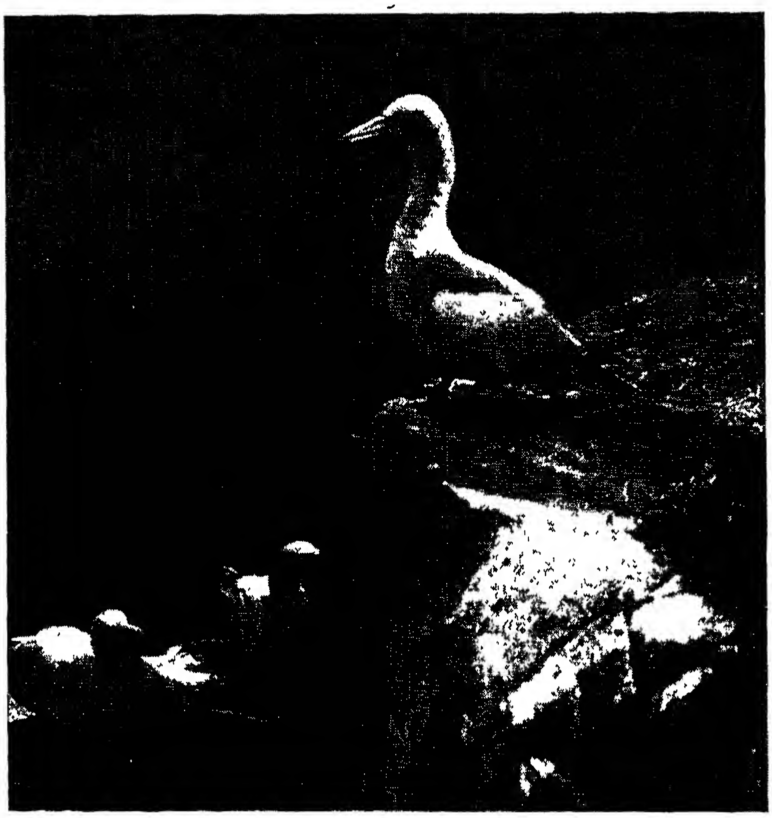
These great birds weigh as much as six pounds or more, and if they eat their own weight of fish in the day it would account for their untiring zeal.

Unless one happens to be near a nesting place, the gannets are not often seen inland except when they have followed a shoal of fish. We have watched them in Scotland in summer time, when they have followed the fish inland for four or five miles from the sea, and have been fishing in a narrow sea-loch. The gannet seems to fly at such a height above the water, that one wonders how it can possibly see a fish at all from that distance, and that the fish are at a considerable depth is evident from the time the gannet takes to come to the surface again. There are nine nesting sites of the gannet in the British Isles. Two are in Ireland, one is in Wales, and the others in Scotland. Mr. J. H. Gurney, in his book on *The Gannet*, gives most interesting accounts of each of these sites and all the history and literature connected with them; it is to this book that I am indebted for the dates quoted.

Until about thirty years ago England could boast of one nesting site on Lundy Island, off the coast of Devon. The birds could never have been very numerous there, and they seem to have left altogether after 1903. Perhaps this colony went to swell that already established on Grasholm, an outlying rocky

island on the north side of the Bristol Channel off the Pembrokeshire coast. This rock stands right out in the tide-way sweeping up Cardigan Bay, and is an impossible place to land on unless the sea is in one of its most placid moods. When we paid a visit there in July the sea was like the proverbial mill-pond, after the turmoil of a tidal-wave the day before, which had made the leaving of the rock a truly terrifying experience for a party of visitors there.

All along the cliffs, and the slopes above them, on the north side of Grasholm, gannets were nesting—a thick mass of white birds from one end of the island to the other. The ground was covered thickly with nests — circular mounds built a foot or more in height, with a depression in the centre. Years of building must have been necessary to attain that height and substance. Seaweed formed the basis of the material, but it was all so thickly covered in a lime-like deposit that it was difficult to see what had been used. On arriving at the top of the rock, the birds nearest to us rose into the air to join the other half of the population which was sailing round and round over the sea in a wide circle, the rim of which just overlapped the edge of the cliff. As the birds were moulting their body feathers by that time, the air was full of down shed by the gannets as they rose into the air. It nearly choked us as it fell, and we breathed the feathers into our noses and down our throats.

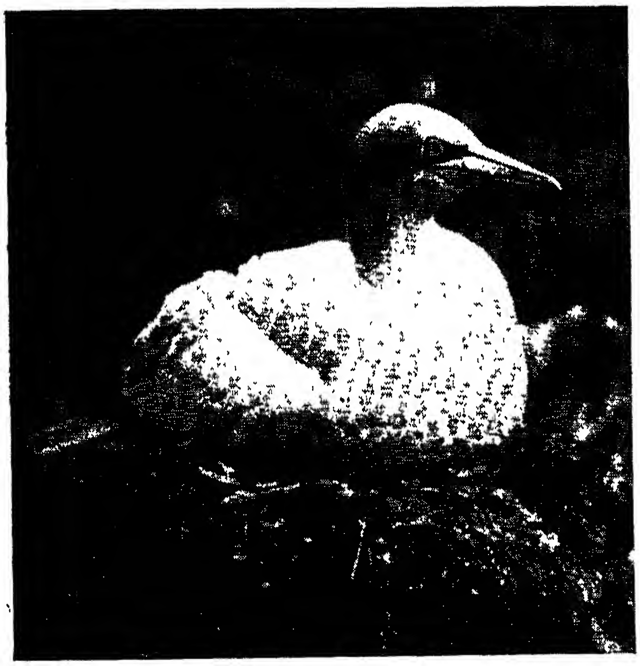


A CLOSER VIEW OF THE BIRDS ON THE BASS ROCK.

In the open spaces between the nests were parties of young birds, gathered in groups like children at school Most of these were in the downy stage, and they looked like enormous powder-puffs with black bills and faces. They waddled uncertainly about, helping themselves along with their wings, and stumbling helplessly over every obstacle they met. Some of the older ones were getting their first feathers, and as these dark feathers took the place of the down the youngsters became mottled and untidy in appearance, as large patches of the down remained on the body for some time before the growing feathers pushed it off.

These gannet nurseries have a curiously untidy and unfinished appearance: there seems to be no method about them. Even as late as July, when the colony had been fully established for over 2½ months, eggs and newly hatched young were found in many nests. If a visit is paid to the nesting grounds of gulls, terns or cormorants, there is an orderly sequence in their proceedings, and, although here and there a freshly laid clutch of eggs is seen, it is obviously the exception. Although in the case of the gannets some accident had probably overtaken the first eggs laid, still, the curious fact remained that there was such a large percentage of them.

Where the birds are nesting on narrow wind-swept ledges, as they do on the Bass Rock, it is interesting to notice the great care the parent birds take of their chick, one of them sitting patiently beside it all the day long until it is well advanced in age. On Grasholm, however, although there were nests on the ledges down the face of the cliffs, the greater part of the colony was comfortably settled on the slopes at the top of the rock whereon was plenty of room for the babies to stumble about at will. They shuffle along on the tarsus with their legs bent, not using the feet at all, which gives them a most awkward mode of progression. Their feet must merely be used as paddles when they swim, though some authorities state that the gannet has another use for them, which is to fold one foot over the other on the top of the egg before sitting on it. This theory may seem as questionable as the tale that the gannet glues its eggs on to the nest with its excreta to prevent their rolling over the edge, but



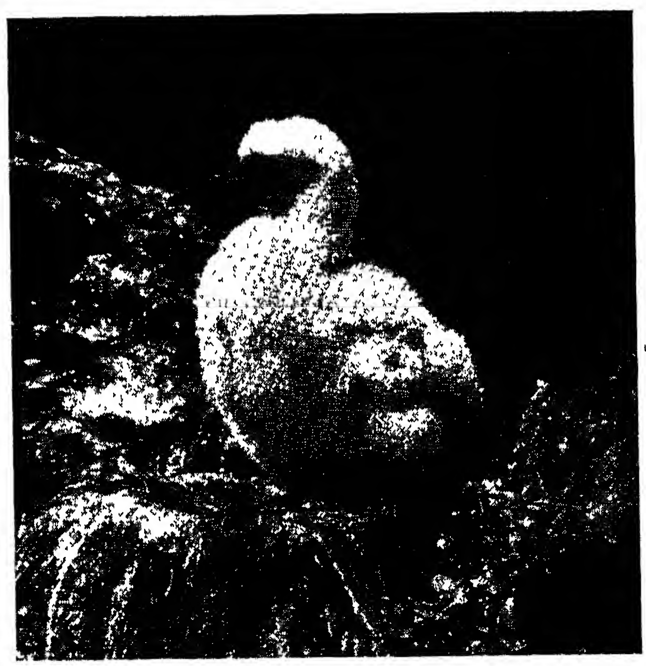
THE ADULT GANNET ON ITS NEST

lately, a friend has told me that he has seen the South African gannets doing exactly the same thing.

Observations on the habits of these birds are not easy to make. They choose the most outlying rocks in the open sea for their nesting grounds, which seldom give opportunity for landing. At Ailsa Craig, as well as at the Bass Rock, there are lighthouses, and the men in charge of the lights are ready to give such information as they have collected, but the ordinary ornithologist, seeking first-hand knowledge, has to do the best he can in the short time allowed him ashore before he has to take his departure. One cannot protest when the boatman shows signs of anxiety about the "tides," but one could well do with more time allowed, especially as the birds are disturbed at first by seeing strangers, and have not returned to settle down again before one leaves. During the two and a half hours which we spent on Grasholm we saw no feeding operations whatever. That the young birds had been fed fairly recently was obvious from the fish they disgorged when alarmed. This habit of disgorging must be of frequent occurrence judging from the behaviour of their neighbours, the gulls. These birds were sitting about on the skyline at the top of the island, from which advantageous position they could overlook the whole gannets' breeding-ground. The instant a young gannet reproduced its dinner, the herring gulls came down to it with a rush and quickly demolished the fish Such easy meals were worth waiting for!

Mr. J. H. Gurney gives some interesting facts concerning the former trade in gannets, and the use that was made of them, which show how valuable these birds were until the middle of last century. In 1661 they were sold in the Edinburgh market for 1s. 8d. ready plucked and trussed. The price then seems to have been at its highest, for it steadily fell, till in 1849 they only realized 9d. The old story of how Charles II remarked that there were just "two things he disliked in Scotland, the soldan goose and the Solemn League and Covenant," shows that even as late as his day they were served at the royal table. The chief value of the young birds was in their fat, which, when boiled down, found a ready sale for many purposes, chiefly medicinal. Their feathers were also valuable, but there was this drawback—that even if they were thoroughly baked in an oven it was impossible to remove completely the most unpleasant smell adhering to them.

In August the young birds were collected. By this time they are usually very fat, having been well fed by their parents, and unable to take any exercise. They are fed for about thirteen weeks after hatching, by which time they are really almost ready to fly, and for the week or more that follows, after their parents have ceased to feed them, they live by absorbing the fat they have accumulated. By the beginning of September, about ten weeks from the date of hatching, hunger makes them attempt to fly, and they leave their nesting ledges for the sea below. By that time the parent birds have given up all interest in their offspring, and the unfortunate youngsters have to fend for themselves. And very helpless they must feel, for they live all day and night upon the water, which must in itself be a great contrast to the solid dry rocks on which their babyhood was spent,



A YOUNG GANNET IN THE DOWNY STAGE.

and having to seek food which they have never seen in its native state before; moreover, the food must be caught, and that in itself takes some time to learn.

It is not to be wondered at, then, that the men whose business it was to catch the young gannets, knew they must be captured while being fed by their parents, for after that, they became so thin that they had no fat on them. Young gannets do not gain their full adult plumage for four or five years. Each succeeding moult introduces more white feathers on head, neck, and body, and gives the birds a very mottled or piebald appearance. Not until the full adult plumage is assumed does the gannet commence breeding. It seems reasonable to suppose that single-brooded birds, only laying one egg a year, must be a long-lived race, otherwise they would be in great danger of extermination. Mr. Gurney quotes one gannet, known by some malformation, which was known to have lived for eighty years. This seems a long life for a bird living the precarious existence of a sea-bird, contending, as it does, with wind and weather in its struggle for existence.

During mild weather in winter, gannets are seen fishing around these nesting grounds, although none land there until the nesting season comes round again. There is nothing to prove whence these birds come. On land, where it is easier to watch the movements of particular birds, the curlew, for instance, departs south to a warmer climate where food is easier to find, leaving our shores early in the autumn. Its place on foreshore and mudflat is taken by visitors from the north, and when spring comes round again,

A GANNET NURSERY ON GRASHOLM.

SOME ADULT BIRDS.

if one is fortunate, as once happened to the writer, a flock of these birds may be seen starting away from the coast where they had spent the winter across the North Sea to their summer quarters in Scandinavia. There is a big migration of gannets to the south in winter, the birds are found on the Moroccan shores, the Azores, and Canary Islands.

It would be hard to imagine any danger on land apart from man that would seriously threaten a gannet colony and disturb its peace, for these birds are quite able to take care of themselves, their bills being formidable weapons of offence. But a few years ago, a pathetic appeal was sent out from Ailsa Craig to the effect that the rats which had originally landed from a wreck, had increased to an alarming extent, and had raided the bird's nesting grounds, nearly exterminating the vast colonies of puffins, guillemots, gulls and gannets, and afterwards in their search for food, invading the houses of the inhabitants. The Royal Society for the Protection of Birds sent a consignment of rat poison there, and after a few week's careful work, the rock was declared almost free again. Later reports, however, tell of the increase in rats, and further steps are now necessary to reduce their numbers as far as possible.

The migration of the gannets is probably entirely regulated by the supply of food. Our British birds commence their departure during the latter days of autumn, and are possibly among those seen fishing off the Azores during the winter. These return to their rocks by the end of February, landing sometimes to inspect nesting sites, ready to begin building early in March.

Book Reviews.

Annual Report of the Empire Marketing Board, 1929-30. (H M Stationery Office. 1*s*.)

The Biological Control of Insect and Plant Pests By W. R THOMPSON, Ph D., D Sc (H.M. Stationery Office 1*s*.).

The chief concern of the Empire Marketing Board is to further the marketing of Empire products in the United Kingdom, and its work is mainly known in this connexion An important and less well-known feature of the Board's activities, however, is its practical interest in the development of the biological and agricultural sciences, to which the greater part of the new report is devoted. A typical branch of this research is the extensive breeding of beneficial parasites, carried on at Farnham House Laboratory, which Dr Thompson describes in detail

The response of Dominion and Colonial entomologists has certainly proved that the laboratory meets a real need in Imperial entomology Since its opening, the list of injurious insects and plants investigated has rapidly increased, and now comprises about sixty species. Investigations suggested by the Canadian Government are proceeding on the parasites of the pear slug, the codling moth, the wheat stem sawfly, the oriental peach moth, and the carrot rust fly, and in almost every case a great deal of valuable information has already been obtained Four shipments, comprising in all more than ten thousand puparia of the sheep blowfly and cocoons of the pear slug, both of which contained parasites, were shipped to New South Wales in 1927 and 1928 Parasites were successfully reared from both these lots of material, and those from the blowfly have since been used for large scale breeding work in New South Wales Shipments of other types of beneficial parasites have been sent to South Africa, New Zealand, India, Barbados, and the Falkland Islands.

Dr Thompson's report is of particular interest as the first of its kind to be published It is divided into four sections. In the first, the author outlines the principles and organization of work on biological control—the preliminary field survey, sample collections, the choice of beneficial species, large scale collections and shipments, the study of introduced parasites in the field, and the results of the experiments conducted. The other sections of the report describe the laboratory and review the practical work so far undertaken

In the most common form of experiments, the beneficial insects attacking a noxious animal or plant are introduced into an environment in which they have never before been observed. The effectiveness of the introduced parasites or predators depends, however, not simply on the presence and abundance of the host insect, but on a precise and definite combination of the environmental factors When a beneficial insect has been introduced into two different regions inhabited by the same pest, experiments have shown that the results may be very different. The introduction of a beneficial insect into a new country thus constitutes, in a certain sense, a new and unrepeatable experiment. Dr. Thompson points out that, for this reason, it is difficult to draw definite general conclusions from such work, which must be supplemented by theoretical considerations of the mathematical order, since the problem is mainly one of numbers

The procedure is to begin with the more general facts of parasite and host interaction as it occurs in nature. These facts are then stated in mathematical language and from various aspects, so that all the deductions concerning the numerical relations involved in the hypothesis can be obtained, with much greater ease than by ordinary reasoning. The basic theory of operations on biological control rests on a few obvious facts. The potential reproductive rate of organisms is such that if all the offspring of every individual of any species survived in any generation, they would, in a relatively short time, occupy the entire area of the globe But organisms do not increase uninterruptedly, on the contrary, their populations often remain comparatively stable, or present oscillatory movements, of which the periods and amplitudes vary with different conditions When a pest is transported into a new environment, without the normal enemies which habitually attack it in its native home, it naturally commences to increase and spread, provided that food material is available and that the physical factors are not more adverse It therefore seems logical to introduce controlling factors whose intensity varies in proportion to the numbers of the pest, that is to say, the parasites and predators who attack it in its native home The success of this introduction as a measure of control depends, in the first instance, on the effect which the new environment exerts upon the introduced species It is therefore extremely important for the entomologist to follow the progress of the parasite carefully from year to year, so as to determine with certainty whether it is increasing or not.

One of the most important pests studied at Farnham is the codlin-moth, which is now found in almost every part of the world where apples are grown Collections of hibernating the moth larvae and parasites were made in fifteen localities situated in nine of the principal apple-growing departments The examination of the material is not yet completed, but up to the present eleven species of parasites have been obtained It has proved difficult to collect sufficient numbers of codlin-moth in the field to provide really large colonies of the parasites, so it was decided to increase the number of parasites by intensive breeding methods. The results are likely to be of great importance to the future of the apple industry

Science in Soviet Russia. By J. G. CROWTHER. (Williams and Norgate 7*s*. 6*d*.).

The author has just returned from a month's tour of the scientific institutions in Leningrad and Moscow, and most of his observations are, he points out, reports of conversations with leading Russian scientists. The book is certainly interesting, dealing as it does with a little-known, though fascinating subject, but it is difficult to escape the impression that, in a strenuous attempt at impartiality, Mr. Crowther is inclined to be a little biased in Russian favour. Conscious of the general unpopularity of the Soviet ideal, the author seems unduly anxious to show that, in scientific research at least, Russia is splendidly ahead of other countries, and certainly much improved as compared with conditions under the Tsarist regime. In doing so, he has given an impression of exaggerated sympathies which he may not have intended.

The author seems to have been impressed by the co-operation of science and industry in Russia. "The organic relations," he writes, "between the technical institutes, industry and the State are impressive All three work together in a way which appears to contrast favourably with that in which the three interact in England. The three important activities seem to be conducted with excessive independence in England; industry, technical education and the State sometimes rather jealously keeping too much to themselves, to their mutual disadvantage.

In Russia the position is different, and one feels that, opportunity for opportunity, the Russian system, which is an extreme form of the German and continental one, will achieve more. The scale and intensity of the organizing effort appear to me to be original."

Yet, earlier in the book, there is a curious contradiction of this desirable co-operation: "The Electro-Technical Institute at Leningrad has over two thousand students on its register, all of which have to pass a somewhat difficult entrance examination. For instance, if there are a hundred vacancies, there may be five hundred candidates Of the five hundred, perhaps two hundred will pass the examination. A hundred of these are selected Children of scientists have a specially good chance of being included in this selection, while those of commercial people have no chance, or only a poor one."

Whatever faults may be found with this book, no one will doubt the author's transparent sincerity.

Liberty. By EVERETT DEAN MARTIN. (New York: W. W Norton & Co. $3).

Dr Martin is director of the People's Institute of New York, and is a master of the technique of adult education. His books on "The Behaviour of Crowds," "The Meaning of a Liberal Education," etc., have had a fair circulation among thoughtful readers in the United States, but this, although published in June of the present year, has immediately become one of the "best sellers." It touches so many sore spots that the people would have to be dull indeed if they did not sit up and take notice; nevertheless, it is a comforting thought that they do The book is written for Americans by one of them, it is the result of ripe scholarship and keen observation, and it is not flattering to the present age and generation. And yet, it is dangerous to shake the finger of scorn too hard at mob rule and the fear of the mob in America, for one may find on the very next page some uncomfortable observation that strikes home outside the United States.

Reading the book through, the conclusion, at least to the reviewer, is irresistible that the Crowd is Our Tyrant, to-day. Also that the crowd, swayed by propagandists, exhorters, and emotional rather than intellectual leaders, is wholly unmindful of freedom and despises the very thought of liberty as soon as it is aroused. This is the modern tyranny, and the problem is to wrest liberty from the mob without the alternative of another tyranny through dictatorship.

There is no short-cut to liberty proposed, for the only road seems to be the path of enlightenment. Let us make a few quotations that expound the present situation. "Any difference of opinion among men may be transformed into a 'moral issue' Virtue has moved her residence. Once enthroned in the conscience of the individual, she now sits on the political platform" (The reviewer would like to suggest that when Virtue takes that place, she loses her character. Neither Socrates nor Plato was ever willing to define Virtue. But our American politicians and the leaders of a quasi ecclesiastical type, set up an Ersatz Virtue that is a malicious and dreadful harridan) Martin goes on to say: "Very soon conscience will function only when the votes are counted. A new and sure method has been discovered for the redemption of mankind; it is this: the way to make men good is to deprive all of them of moral responsibility."

Earlier in the work the ideas of liberty are associated with cultural traditions. The people who came to America before the revolution were largely English and Scotch non-conformists; the great majority belonged to the lower middle class and the proletariat They missed the liberalizing influences of the Renaissance, which explains much of puritanism For generations the dominant American tradition and philosophy of life was Calvanistic rather than Humanistic "When Calvinism declined it did not so much yield to a more critical, intellectually respectable, urbane and aesthetic philosophy as might have been expected; it just slumped into literalistic bibliolatry, moralistic intolerance, Rousseauist humanitarianism, evangelistic enthusiasm, with scarcely any intellectual content whatever" This is severe, but it hits the mark in many places.

Later in the book the author declares: "History is full of the mischief such men have wrought whenever they have had the power. Their spirit of intolerance is very infectious, first because it is always disguised as zeal for righteousness, and secondly, because the crowd mind being, as I have shown, always potentially homicidal, once it is called into action, is very susceptible to the appeal of 'righteous indignation' Intolerance begets intolerance both for and against itself Now when there is a rapid spread of intolerance accompanied by . . extension of the power of government and . a decline in the quality of statesmanship there is every danger of an orgy of persecution. There are indications that the American people are setting the stage for just such a performance."

We could quote clear beyond the space available, but the foregoing may show the purpose of the book; to awaken Americans and to point out that the greatest enemies of freedom and of liberty are not to be found among foreigners or in the designs of either political party, but rather in their own easy acceptance of popular slogans as shouted and followed by the crowd The tyrant does not sit with crown and sceptre upon his throne in civilized countries any more. He is with us, nevertheless, as cruel and as vindictive as ever, in the voice of the mob. There abides the greatest danger to our cherished freedom and liberty, not only in America, but throughout the civilized world

ELLWOOD HENDRICK

The Technical Arts and Sciences of the Ancients. By ALBERT NEUBURGER. Translated by HENRY L. BROSE, M.A., D.Phil. (Methuen. 42s.).

It is a matter of common observation that the general run of scientific and technical textbooks, if they do not entirely ignore the historical aspect of their subject, rarely deal with it satisfactorily. All too frequently authors seem content to repeat what has been said by their predecessors, without endeavouring to ascertain if later research has proved it inaccurate or out of date. A work like Neuburger's "Die Technik des Altertums," now published in an English translation, meets a long felt want—to use a much overworked phrase. The amazing erudition of the author ranges widely over the technical achievement of the ancients. Not only does he cover such obvious subjects as the preparation and working of metal, wood, and leather, ceramics, spinning and weaving, the production of fire, habitations and transport, together with their subsidiary and concomitant arts; he also explores such little-known topics as the preparation of soaps, fats, oils and perfumes, refrigerating and preserving, dyeing, and the technique of painting. The value of his work lies not merely in the text, it is much enhanced by the very full illustration of the appliances used, with reproductions from contemporary sources, paintings, sculpture,

and engravings from Egypt, Greece, Rome, and elsewhere. The pictures in the section on mechanics and machines may be noted in particular as excellent. They will give a valuable, and to many, an unexpected, gauge of the technical ability attained by the ancient engineer and mechanical expert. The greater part of the material is drawn from Egypt, Greece, and Rome, with references to India and very occasionally to primitive peoples for purposes of illustration.

It would have been an advantage if greater use had been made in some sections of the material made available by prehistoric archaeology outside the Mediterranean, and with which the author is mainly pre-occupied—for instance, in the sections on metallurgy, habitations, and agriculture Reference might have been made to the use of the lamp in palaeolithic times The wide range of subjects covered make this book one of the greatest interest to the general reader, while as a book of ready reference it should be in the library of every school and educational institution.

The Wilderness of Denali. By CHARLES SHELDON. (Scribners. 21*s*.).

If this book merely recounted the adventures of one of the most famous big game hunters of recent years, it would be well worth reading. But it does far more than that; it describes the habits of a variety of smaller and lesser known mammals, and therefore contains much of interest to the student of natural history. For the author was not only a prominent sportsman, he was also a distinguished naturalist. The late Charles Sheldon chose as his hunting grounds previously unexplored territory, and was thus able to return with valuable specimens. Incidentally, he was responsible for the discovery of many new species.

This book is an account of the explorer's expeditions in the wilderness surrounding Mt. McKinley, where the majority of his discoveries of natural life were made The manuscript was prepared from the author's Alaskan journals, and is therefore in diary form. A diary always conveys an atmosphere which the more conventional "account" seldom achieves; the diary is written at the time of the incident described, amid the actual surroundings in which the author's experiences have taken place, and the account is far more vivid and real than a description compiled from an arm-chair sometimes months and years after the events.

Much of Mr. Sheldon's book might well be quoted at length were space to permit. His observations of the habits of the wolverine are particularly interesting The explorer was fortunate enough to capture a female specimen, which he chained in a small log house constructed for the purpose. "The reputation of the wolverine for robbing caches and the baits of traps, and even for eating fur animals caught in traps, is well deserved," he wrote. "It persists in these habits and, because of its great strength, does considerable damage to caches and deadfalls. Wolverine have been known to carry off animals caught in traps, with the traps attached, but many descriptions of these habits are not limited to exploits among traps, but include tales of thieving, malicious destruction of property, the soiling of food and even the carrying off of empty traps. Reliable proof of such statements is not forthcoming and, in view of my own observations and inquiries in the north, I am inclined to regard them as products of the imagination."

Mr. Sheldon had also a unique opportunity of studying the habits of the Alaska-Canada jay. "Early in August two or three of the birds appeared and, when fresh meat was brought in, others kept coming until nine in all remained about the camp. They became more and more familiar until, in about three weeks, some of them would alight on my hand and grasp the meat held in my fingers. When I repeated a short whistle they would all fly towards me and alight upon my head, shoulders and hands, and would quarrel while picking the food. When I was left alone in the camp, the jays became still more friendly and seemed to adjust their mode of living to one which depended almost entirely upon me. They were persistently dominated by one insatiable passion, that of storing food. Should meat, doe, or any cooked food except fruit be placed in a spot accessible to them, they would at once begin to peck off pieces and store them in branches, crotches or pieces of bark, returning immediately to repeat the operation. Like ants, they would continue to do this during the whole of the day until all the food was cached.

"The food was stored carelessly, particularly when a large quantity stimulated their activities, in which case they stored blindly and immediately forgot where they had put it. Many times they were seen searching for the storing places. Seldom did they stop to eat any of the food offered them."

The book contains over one hundred photographs and a map showing the neighbourhood surrounding Mt. McKinley Appendices enumerate the birds of the Upper Toklat region, the mammals of the Alaska range, new species of mammals discovered by the author in Alaska and elsewhere, skins and skulls collected and presented to the United States National Museum, the localities in which Charles Sheldon hunted, and a list of the tribes and bands mentioned in his diary.

George Eastman. By CARL W. ACKERMAN. With a Foreword by LORD RIDDELL. (Constable. 24*s*).

A large part of this book is naturally devoted to the history of photography, and particularly to the story of the Kodak film and camera In the earlier chapters the author deals not only with Eastman's early inventions, but also with the discoveries of his contemporaries. The later part of the book is mainly biographical, and reviews the inventor's wide philanthropic activities and particularly his interest in education. Since Eastman is chiefly known, at least outside America, as the parent of the Kodak, the early chapters are likely to prove most interesting. The story of his ancestry and youth might, perhaps, have been more briefly told, and in this chapter, particularly, Mr Ackerman displays the biographer's most irritating offence—a passion for details which are neither remarkable nor particularly pertinent.

Eastman's early accounts, which he kept meticulously, show a practical interest in photography as early as 1869, and three years later it is recorded that he spent £20 on lenses and other photographic equipment. In the same year he arranged to take lessons from a local photographer But photography remained a hobby until 1877, when Eastman first realized the possibilities of commercial production. It is interesting to recall that his inspiration first came from this country, for it was an article in the *British Journal of Photography* that "started him in the right direction." The article, which gave the formula for making a sensitive gelatine emulsion, led Eastman to compose a solution which could be coated and dried on a glass plate while retaining its properties long enough to be used in the field Thus the necessity for carrying a dark tent and silver bath were eliminated. A refusal of financial assistance from a wealthy uncle was the first of many difficult obstacles, but Eastman withdrew his own

savings from the bank, increased his purchases of photographic materials, and by 1879 was not only making plates which were "entirely successful," but had invented an apparatus for coating them.

In 1884 the inventor produced his first film The process of making transparent film was first conceived by coating a support with a solution of nitro-cellulose, then coating it with emulsion, and afterwards stripping it off. Both paper and glass were employed as a temporary support The solution was composed of soluable gun cotton dissolved in concentrated sulphuric ether, and an equal part of grain alcohol, with ten grains of cotton to an ounce of solvent. A small quantity of castor oil was added to give the solution more body. The glass was first coated with this solution and allowed to dry. A coating of rubber and benzine was then applied Ten successive coatings of nitro-cellulose solution were applied to the glass. Experiments were also made using paper as a support, and films were produced upon which it was possible to make pictures by leaving the films upon the paper support during the exposure and development, and stripping them afterwards Thus the first practical film in the history of photography was discovered.

If Mr Ackerman's book has a fault it is the abundance of footnotes, many of which occupy half of the page. But the whole story is an inspiring record.

Egyptian Sculpture By MARGARET ALICE MURRAY. With a Preface by PROFESSOR ERNEST GARDNER. (Duckworth 15*s*.)

Egyptian sculpture, and indeed Egyptian art generally, has certain essential qualities which mark it off from the fine arts of any other nation or race in history. As Professor Gardner points out in his preface, no other art of any one people can be studied in its development over a longer period of time. Notwithstanding the immense interval between its beginnings and its close, when it became decadent and finally disappeared under the weight of outside influence, it never lost its essential characters. The earliest and the latest examples in date equally bear the unmistakable stamp of their Egyptian origin. As Miss Murray reminds her readers, the peculiar characters of Egyptian sculpture were the product of a combination of certain factors which can be analysed with singular directness. The Nile landscape with its sharp outlines and absence of rounded contours, the architectural use of sculptured figures, and in the vast majority of cases the ceremonial character of the representation, were the essential elements Yet notwithstanding the forces which make for a certain rigidity and conventionalism, Egyptian sculpture has an attraction which, as it were, irradiates through its majesty and force Many examples, of which the limestone head of Nefertiti now in Berlin is the most conspicuous, have great charm. Yet even in the period of Akhenaten, when the artistic and religious ideals of that reforming monarch allowed play to realism and an exact portraiture, the sculptured figure never descends from a high level of dignity. Even at other periods convention and ritual idealism did not entirely obscure individual character. In fact, one of the attractions of a study of Egyptian sculpture is the appreciation of the character of its subjects through the ages

Miss Murray's acquaintance with her subject is intimate and has guided her well in the selection of her very full illustration of this branch of Egyptian art. Her comments on each example, without being too detailed, give the reader the main points requisite for its appreciation The notes on technique will help to an understanding of the measure of success which the Egyptian artist attained in solving the problems imposed by the conditions of material and the purpose of the artistic product.

The Letters of Two Fishermen. By HUGH COPLEY (Frederick Warne 6*s*)

This book contains imaginary correspondence between two fishing enthusiasts, one living in West Africa and the other in Birmingham In a preface, the author warns his readers that ideas are put forward which "are, perhaps, against the teachings of the classical masters of the art, but it can at least be claimed that they have all been tried out in practice on many waters. The possibilities of the West Coast of Africa from a sea fishing point of view are, even to this day, practically unknown and unexplored, yet there are many places on the coast which would yield magnificent sport to anyone trolling with a dead bait or a six-inch Wilson spoon. This last bait is not as well known to British anglers as it should be"

The chief interest of the book for those who are not fishing enthusiasts lies in the glimpses afforded of the ingenious methods of negro fishermen, which, it will be recalled, were described in *Discovery* last year But the angler's best known characteristic is prominent in the letters of the West African correspondent, and his own prowess with the line is dwelt upon in more detail than the activities of the native fishermen

Mr Copley's book makes no pretence of literary merit. The letters are written in chatty vein, with a strong flavour of the slang which is reputed to be an important part of the true sportsman's vocabulary Anglers will doubtless discover many useful hints, and certainly anyone who happens to be sojourning in West Africa and is equipped with a "dead bait or a six-inch Wilson spoon" will find Mr Copley's book an invaluable work of reference.

Pythons and Their Ways By F W FITZSIMONS (Harrap & Co. 7*s* 6*d*.).

This is a charming book, written by one who has not only studied his subject, but who has also the gift of writing so as to make the reader feel that he is actually witnessing the incidents described

The only criticism we can make is with regard to the first sentence of the first chapter Most of us zoologists are brought up to believe that the pythons are the Old World group and the boas the New World group of the "constricting snakes," and it comes rather as a shock to read that "Pythons are to be found nearly everywhere in the world where the sun is sufficiently warm for their comfort . in South-eastern Europe, Central and South Asia, Africa, Australasia, South and Central America, Western North America, and the West Indies" (p. 11). This is, I feel, a misuse of the term "python," and, in the appendix, the author himself divides the Order Ophidia into "Pythons (subfamily Pythoninae)" and "Boas (subfamily Boinae)"

The author does not deal with the boas, the whole book being concerned with the true pythons. Chapter I is mainly about their habits, and almost all the rest of the book, although incidentally referring to habits, consists of experiences with these large snakes—experiences of his own, and in one case of his courageous wife, which make cold shivers run down the reader's spine. We have not come across many "animal" books so enthralling as this one, which we read in two sittings having difficulty in putting down the book

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Editorial Notes.

WE are fortunate in publishing this month an important review of the British Association's recent history, written specially for *Discovery* by Mr. O. J. R. Howarth. The article brings the history of this great organization up to date, and completes the record of a century's endeavours. Founded in 1831, the British Association for the Advancement of Science has grown steadily in influence, and enters its centenary year in a stronger position than ever. In earlier years the meetings were regarded with open contempt, and only after long and patient efforts on the part of pioneer members was the Association publicly recognized. With just pride the Secretary draws attention to the fact that, almost alone among societies of the kind, it has not raised the original subscription of one pound, instituted a hundred years ago. On the contrary, by concessions granted to students and through other causes, the cost of membership has actually been lowered. As a result the gross receipts are smaller than formerly in proportion to the attendance at meetings, and the continued progress is therefore all the more remarkable. The discussions that will take place at Bristol this month include many subjects of interest to readers of *Discovery*, and we take the opportunity as in previous years to publish articles related to the programme. The new President, Professor F. O. Bower, has had a distinguished career, and with his permission we publish a biographical sketch, written by a former colleague. Visitors to Bristol will find much interest in the Vice-Chancellor's description of the University, and in the article on tobacco—an industry long associated with the city. Among the other subjects attention may be drawn to the plea for a national Folk Museum, advanced by Mr. E. N. Fallaize. It has just been announced that the Government is considering plans for such an institution, towards which a sum of £50,000 has been promised. We shall publish a report of the meeting in our next number

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This summer the British School at Athens has been excavating the site of the Heraeum, which was situated on a headland north of Corinth. Describing the results in *The Times*, Dr. Humfry Payne states that the occupation of the Heraeum goes back to the latter part of the eighth century B.C., from which time onwards it seems to have played a considerable part in the history of Corinth. The district provided valuable grazing and cultivable ground, and must have been an important source of timber for ship-building. It was also clearly of great strategic importance, being strongly fortified like the neighbouring towns of Peiraion and Oenoe. The excavations have revealed a temple in a field near the harbour, but though of considerable interest it is evidently not the famous Heraeum. The most striking discoveries were made in a building nearby—a "Treasury" in which the votives to Hera were stored. Most of the objects were fragments of pottery, dating from 750 to 200 B.C., the best examples being Protocorinthian (seventh century). A remarkable specimen of this period is the lid of a box decorated with a scene from wild life. The design is carried out in a simple but effective style, perfectly suited to the subject matter. The Treasury also contained some imported objects, mostly of Egyptian origin. It has long been thought that Corinth had close relations with Egypt, and these discoveries seem to provide concrete evidence.

* * * * *

Excavations in Rhodesia, also reported in *The Times*, have thrown new light on the antiquity of

metallurgy in southern Africa. For two years past an Italian expedition has been working at various sites, under the command of Captain Yatti, and the metal discoveries were made this summer in the Mumbwa Caves. These are distant 130 miles from Broken Hill, the scene of the discovery of Rhodesian Man about ten years ago. In front of the cavern large quantities of slag and iron ore were scattered, the whole providing the first example of the kind which can be dated in a strictly archaeological manner. It now appears that a knowledge of smelting existed in Rhodesia about 3,000 years before the arrival of the Bantus, whose mining activities are associated with the famous ruins at Zimbabwe.

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While our August number was in the press we received a visit from Sir Hubert Wilkins. In discussing the report of his submarine expedition to the North Pole next year, the explorer told us some interesting details of his plans. The proposal is to travel on the surface where open sea is available, submerging when ice is encountered. In order to discover the extent of the ice areas, a captive balloon will be used to take aerial photographs, which will provide a map for navigation purposes. Whether it will be possible to prospect the ground conditions adequately in this way must await further tests, but Sir Hubert is confident that the method will prove successful. A thorough acquaintance with Arctic conditions is, of course, an important factor, but an explorer of Sir Hubert's experience will tackle the problem from a standpoint that is thoroughly scientific. A complaint was expressed that British financiers had failed to support the expedition, and that funds are accordingly being raised in America. Many people will share his wish that a British backing could be provided, but owing to high taxation there is less money than ever available for adventures of this character.

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Preliminary plans are announced for the Faraday celebrations to be held in London next year. In the spring of 1831 the electrical pioneer began his experiments on the induction of electric currents; and on 29th August he made the discovery in which lies the origin of the dynamo, and the starting point of the utilization of electric power. On that day, as his diary shows, he wound two coils of wire on to opposite sides of a soft iron ring, connecting one coil to a battery and the other to a galvanometer: at "make" and "break" of the battery circuit he observed deflections of the galvanometer connected in the other circuit. This simple experiment has given rise, in less than a hundred years, to the science of electrical engineering and to the great electrical industry, in all its phases as we know it to-day. In arranging the celebrations, it is fitting that the lead should be taken by the Royal Institution, for it was to the well-known premises in Albemarle Street that Faraday came in 1813, a youth of twenty-two, to become assistant to Sir Humphry Davy who was then the professor of chemistry. Later he succeeded Davy, and there gave his famous lectures. In the centenary programme the Royal Institution will have the assistance of the Institution of Electrical Engineers, and will also cooperate with the Royal Society and the British Association.

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Throughout his life Faraday kept a careful diary, written in his own hand, of all his experimental work. On his death these "Experimental Notes" were bequeathed to the Royal Institution, and for over sixty years they have been its most treasured possession. Although the philosopher himself made extensive use of it in the preparation of his published works, the diary itself has never been published, and to mark the forthcoming centenary the managers of the Royal Institution have resolved to publish it in full. The work is now in course of preparation, and it will be issued on their behalf by Messrs. G. Bell & Sons. It is intended to complete the work in about eight volumes, of which two or more will be ready by September, 1931.

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The police at Brighton are making experiments with portable wireless receivers. The plan is to equip policemen with "pocket sets" by which they can keep in touch with headquarters while out on patrol. A special committee of police chiefs is considering the scheme in conjunction with wireless and motor experts, and if the preliminary tests are successful it is hoped to employ wireless control throughout the country. It is reported that the set can be carried in a breast pocket, and weighs no more than a policeman's torch. Miniature headphones and a "buzzer" are also part of the equipment. A message broadcast from the police station would reach every constable within the city radius. Presumably a special wavelength would have to be employed, but we foresee an amusing situation when a "crook" (or a practical joker) discovers the secret and sends out a false alarm!

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It is announced that the sixth annual Norman Lockyer Lecture will be given by Professor Sir William Pope, F.R.S., on 13th November, at 4.30 p.m., in the Goldsmiths' Hall. The president of the British Science Guild, Sir Samuel Hoare, will take the chair at the lecture, the title of which will be published later.

The British Association : 1920-1930.

By O. J. R. Howarth, M.A., O.B.E.

Secretary of the British Association for the Advancement of Science.

The following review of events during the past ten years forms an interesting addition to Mr. Howarth's history of the British Association ("A Retrospect: 1831-1921"), and brings the record of its activities up to date. The period has included the Presidency of the Prince of Wales and the grant of a Royal Charter.

THE last decade of the British Association's first century has been notable in its history. The Prince of Wales honoured it by accepting its presidency in 1926. Over three thousand members assembled for the meeting in Oxford that year. The sole occasion for regret then was that only half of them could see, as well as hear, the presidential address delivered in the Sheldonian Theatre, that famous little building of which the design so curiously—and for a university auditorium, so properly—induces a spirit of intimacy between speakers and audience. In it the members who were fortunate enough to secure admission, appearing in every sort of academic costume, imperial and foreign, staged a spectacle such as the Association has probably never before displayed; alas, that no artist was present to record it. Those who could not see the address delivered could at least hear it, for it was relayed to two other halls. Incidentally, it seems likely that a similar subterfuge of science will be needed at the centenary meeting next year, for the Central Hall at Westminster can scarcely be expected to accommodate the total attendance, and the Albert Hall, which it had been intended to put to the use for which it was designed, will not be available. Relaying, it may be added, was first put into practice for the Association at the Liverpool meeting in 1923, for Sir Ernest Rutherford's address. That also was the first to be broadcast, and we were told as a matter for congratulation that it was well heard in Switzerland. And this but seven years ago!

Darwin's House.

The Association received its Royal Charter of incorporation in 1928, a gift implying new responsibilities, and enabling one, in particular, to be assumed. For the Association, unchartered and having no legal entity, could not have accepted the gift, and the signal honour of the custodianship, of Darwin's house at Down. The writer of these lines will not easily forget the moment when, following upon Sir Arthur Keith's appeal at the Leeds Meeting in 1927, it fell to him to open a telegram which was delivered in the office on the following morning. In it Mr. George Buckston Browne, answering the appeal, announced his intention of buying the property, and it is thanks to him that, in the words of the Council's report, "the Association now possesses in custody for the nation Down House, where Darwin thought and worked for forty years, and died in 1882. Mr. Buckston Browne, besides vesting in the Association the sum of £20,000 for the maintenance of the property, has fully restored the house (an extensive and urgent work), and has placed the ground floor in a condition appropriate to exhibition to the public; in particular, the Old Study, where the 'Origin of Species' was written, has been brought as nearly as possible to an exact replica of its condition in Darwin's time, with much of the original furnishing and copies of, or close approximations to, the rest. Under Mr. Buckston Browne's inspiration, members of Darwin's family, and others, have liberally given original furniture and other objects of interest for preservation in the house. The restoration of the gardens and the Sand Walk is also in progress."

11,000 Visitors.

That the house, curiously difficult of access as it is for a place so near to London, should have been visited by 11,000 people during the first year of its opening, is sufficient justification for its preservation as a memorial; but that the place should be associated with some form of scientific work is an objective of which the attainment would crown the enterprise.

The Association, at the outbreak of the Great War in 1914, was meeting in Australia, and the meeting was carried through with little material alteration of programme. According to legends which (as about other topics of the time) sprang up like mushrooms, the meeting was abandoned and one of the steamers conveying a number of the members homeward was sunk by the "Emden." Neither of these things happened.

Meetings were held also in 1915 and 1916, but with growing difficulty, and by 1917 it was apparent that

business could not be carried on as usual. Therefore in that and the following year no annual meetings in the accustomed sense took place. In 1919 the series was renewed, and in a new place, where the Association had never met before—Bournemouth.

Anyone who judged solely upon the attendance of members at that meeting and the next, in Cardiff, might have feared that the Association had in some measure lost its hold. And so much was actually asserted; but those who did this forgot that these two meetings, as it chanced, had been held in localities where meetings, however successful otherwise, have been always numerically small. Scottish meetings, however, had always been large, and, true to type, the Edinburgh meeting in 1921 went far to restore the balance. Even the faith of the permanent executive had been insufficiently strong, and probably for the first time (and, it may be hoped, for the last) an insufficient number of membership tickets was provided for this occasion. Since that year, attendances have been on the whole satisfactory, and out of the four largest meetings recorded in Great Britain, two have occurred in the past decade—at Liverpool in 1923 and at Oxford in 1926.

Membership and Influence.

This subject is worth consideration from the administrative standpoint, for the Association must depend upon its membership—not merely financially but for the maintenance of its influence, which may be claimed to have definitely increased in the period under review. That dependence introduces certain problems. Thus: (1) the Association has not raised the ordinary subscription of £1 for attendance at an annual meeting, which was fixed in 1831. There cannot be many institutions in a position to make this assertion; but the Association has gone further by introducing a half-rate for students. And (2) the proportion which the gross receipts from membership subscriptions bears to the total attendance at any meeting is actually smaller than it was, owing to the above and certain other adjustments. But (3) the Association, organized as it is, dependent for the bulk of its membership upon one meeting at a different place every year, and offering only to the most ardent "cultivators of science" any other inducement to permanent membership, is subject to a variable limitation of membership in any one year.

There is a measure of geographical control over membership, as has been suggested already; moreover, there must be a limitation of accommodation with comfort, varying according to the size and character of the town where a meeting is held. It is not suggested that this latter limitation has ever been actually reached in any place where the Association has met, but it has been within sight more than once. And there are places where the Association has met in the past, which probably would hesitate now to invite it for a meeting, on the ground that they could no longer meet its requirements. It would be far worse if the Association were compelled to refuse an invitation from any place on the ground that a sufficient return in subscriptions could not be expected. That, again, has not happened. But either it must have happened, or the subscriptions must have been increased (with the almost certain result of a fall in membership), or some of the Association's activities (such as the financial support of research) must have been reduced, if the Association since the War had not been made the recipient of munificent donations, for general purposes, from Sir Charles Parsons and Sir Alfred Yarrow. To these should be added, among other benefactions, a substantial sum subscribed by old life members by way of addition to their original composition fees, and also monetary help afforded by the Department of Scientific and Industrial Research to some of the researches undertaken immediately after the War. Among these researches (though not one of those so assisted) probably none was of higher public importance than that which resulted in the publication of a remarkable series of studies of British finance and labour.

Thanks to the generous helpers named, the finances of the Association have for the moment been stabilized. For the moment; but the Association has new commitments (notably in relation to Down House, and to the Centenary celebration next year) and possibilities of activity in new directions at the beginning of its second century which must depend for their full fruition upon financial considerations. If, therefore, it should be decided to appeal for further endowment, the work of the last decade of the Association's first century (not to mention that century's full record) may be taken to offer a measure of justification.

Overseas Meetings.

In the decade under review, there have been two meetings overseas, in Toronto (1924) and in South Africa (1929). It is a happy feature of the post-war period that closer relations have been established between the British and the American Associations for the Advancement of Science. That Association has been frequently represented at our meetings; to its own (which take place in winter) there is unfortunately less opportunity to nominate British

representatives; but the Council was able to delegate Professor H. H. Turner to that duty at the New York meeting in 1928. In 1924 the American Association had generously undertaken to bring the Toronto meeting of the British Association specifically to the notice of its members. The result was that about 800 American scientific workers attended the meeting, which therefore proved to be the most comprehensive occasion which has arisen of recent years for co-operation between British and American science, for not only did the meeting itself give opportunity for this, but many of the British visitors enjoyed American hospitality either before or after it, together with some sight of American scientific advancement in universities and research stations.

Progress in Canada.

The Toronto meeting was otherwise notable because it was the first occasion of a second meeting in the same city of the Dominion (the previous meeting in Toronto was in 1897), and the remarkable developments in the university and the city during the intervening period could be appreciated by those visitors who were present on both occasions. Still more was this true in relation to the journey to the west which took place after the meeting. Those who had travelled across the western provinces after the Winnipeg meeting in 1909, and now did so again, could not fail to perceive the wonderful development which had taken place in fifteen years, not only in the special cultivation, but also in the general appreciation, of science. Universities either completely new or vastly enhanced in equipment, were seen in every western province. In 1909, when the train stopped for receptions in the western cities, formal communications between visitors and hosts took the form of speeches, at times with some reference to science, at other t mes with none. Of scientific lectures there were hardly any. In the course of the western journey in 1924, forty lectures were given by members, including several at special sectional meetings held in the University of Saskatchewan at Saskatoon and the University of Alberta at Edmonton. Such lectures were asked for by the institutions visited, where in 1909 (speaking generally) there was none to ask. And in return the visitors heard from workers on the spot accounts of their own scientific problems and of their work, where in 1909 there was none to tell of them. In those fifteen years the seed which had been sown had begun to yield harvest; and there was gratifying evidence that some of it, however tentatively, had been sown during the Association's visits in 1909 and earlier. The route of the journey in 1924 was more comprehensive than any followed previously, as it led westward by the transcontinental line of the Canadian National Railways and returned by that of the Canadian Pacific system. Many visits or deviations were arranged to suit special interests, such as those of geologists, zoologists, and agriculturalists; but all interests were constantly engaged.

In 1929 the Association paid its second visit to South Africa. The support accorded in South Africa itself by way of membership of the Association was very materially less than that given in 1905. This was a "rub of the green" such as the Association with its present organization, and probably almost any institution under present conditions, must on occasion endure, and it connoted no lack of interest in science in the Union. Public lectures were asked for with a gratifying freedom, and as far as circumstances allowed, they were given. Hospitality was unlimited, as it always is in the Dominions. And here let it be said that the Association, on the occasion of its Centenary Meeting next year, has an opportunity unique in our time, not indeed to repay in full its debt for hospitality overseas, but at least to demonstrate to visitors from overseas its appreciation of their Dominions' generosity in the past; of this opportunity home members will not be slow to take heed.

Wider Activities.

The effects and results of overseas meetings of the Association are never confined to the meetings themselves, and this fact was exemplified afresh in 1929. The first visit of its type to a colony in the Association's history was that paid to Kenya by two parties on their way home from South Africa; a week in each case was devoted to sight-seeing scientifically arranged and informed, and lectures were given by visitors. Other journeys by parties in the Union and Southern Rhodesia were of great scientific interest, and much important work was done outside the actual programme. Thus, some of the visiting astronomers were able to enquire into the extension of observatory work in South Africa; the anthropologists and the archaeologists had opportunity to see something of native peoples and evidences of their earlier arts and activities; the geologists co-operated with the International Geological Congress, not only in meetings but in field-work, and the agriculturalists with the Pan-African Agricultural Congress at Pretoria. The Association française pour l'Avancement des Sciences invited members not attending the South African meeting to join it at Havre, repeating the friendly gesture of 1914.

An investigation of certain of the famous Rhodesian

ruins, at and in the neighbourhood of Zimbabwe, was carried out under the direction of Miss Caton-Thompson, at the request of the Council of the Association and at the charge of the Association aided by a grant from the Rhodes Trustees. Miss Caton-Thompson's work carried on, amplified, and confirmed that of Dr. Randall-MacIver done on the occasion of the Association's previous visit, in 1905. During the present year a loan collection of objects from Zimbabwe and elsewhere was organized on behalf of the Association with the generous co-operation of museum and other authorities in Southern Rhodesia and the Union, and was exhibited at the British Museum. Miss Caton-Thompson's report of her work will be published in due course, with the aid of a grant from the Association.

Imperial Functions.

No apology is offered for referring to the Toronto and South African meetings more fully than the rest. An enthusiastic president said of the first of the Association's meetings overseas (1884) that it marked a distinct epoch in the history of civilization. Possibly the speaker's intention was clearer than his meaning; but these meetings overseas are outstanding events in the history of the Association and in the experience of those who take part in them. Other organizations help to strengthen the scientific bond throughout the Empire, but they represent each a single science or group of sciences. The British Association is alone, in this connexion, in covering the whole field of science; for that reason if for no other its imperial functions are among its most important.

A spirit of co-operation which was not known among scientific societies in former years has made itself manifest during the decade. Once distilled, it has proved very fairly strong, though unless conserved it may be subject to a tendency to evaporate. It was not strong enough to bring about a union between the Association and the British Science Guild, for which a scheme was worked out. Within the Association, however, it has shown itself since in 1921 the organizing committees of the Sections took to meeting jointly as well as severally to consider their programmes, an excellent provision, since it gave opportunity to make fuller use of one of the Association's exclusive attributes, that of providing a common meeting-ground for all kinds of scientific workers, and to arrange more of the joint meetings between two or more sections which make possible the discussion of what are called "border-line" subjects. The same spirit of co-operation has acted in another direction by causing the calling of meetings of representatives of all appropriate societies to deal with questions of common interest, such as that of establishing a central institution for the encouragement of anthropological studies, and again—a matter of still wider concern—the liability of scientific societies to income tax. In this last connexion the Association has found it possible to offer a measure of advice to other societies when appealing against the taxation of their incomes, and it was offered that the office should become a recording centre of the results of individual societies' appeals, in order that such records might be available for consultation and general guidance.

The institution of the joint meeting of organizing committees was one of the most valuable reforms introduced by the former General Treasurer, Dr. E. H. Griffiths; a second was the investment of life compositions (a practice which had escaped attention previously). A third was the establishment of the so-called exhibitions, which enable a student selected by each university and university college in the United Kingdom to attend an annual meeting without expense to himself or herself. Several of the institutions invited to nominate exhibitioners are able to assist others of their students to attend meetings, where they may hear and make personal contact with their seniors in their selected branches of science. The value of this new provision for science students is self-evident, both from their own standpoint and from that of the Association, for it is in the hands of these and their contemporaries that the future of the Association lies.

Safety in Mines.

In *Discovery* for August, particulars appeared of a new safety lamp that combined the "flame" detection method with electric illumination. The U.S. Bureau of Mines has since issued details of another device for detecting carbon monoxide. This consists of an easily crushed cotton-covered ampoule filled with a solution which changes colour when exposed to air containing carbon monoxide. In appearance the ampoule is similar to those filled with aromatic spirits of ammonia for giving inhalation treatment, or those filled with iodine for first-aid treatment of wounds. In use the carbon monoxide ampoule is crushed, which wets the cotton covering with the solution. It is then exposed to the air to be tested. After a prescribed period of exposure the colour is compared with a chart and the amount of carbon monoxide estimated. The detector was devised primarily for examining the air of man-holes and sewers.

The New President: Professor F. O. Bower, F.R.S.

(By a Special Correspondent.)

THE President of the British Association for 1930 is Professor F. O. Bower, the distinguished botanist, who occupied the chair of Botany at the University of Glasgow from 1885 to 1925. Before his appointment to the Scottish chair, Dr. Bower was Lecturer in Botany at the Imperial College of Science, South Kensington. He was born at Ripon in 1855, and was educated at Repton and Trinity College, Cambridge.

Professor Bower has made research and the teaching of botany his life work, wisely choosing to devote his attention to one branch of scientific thought than to embrace a variety of subjects which have no bearing on the main interest of his life. Not every Englishman can claim to have been a success in a Scottish chair, but there is no doubt that the new President was eminently successful, both in the teaching of a subject usually considered rather uninteresting and in his sympathies with the students in their athletic and other recreational activities. As a lecturer Dr. Bower was fluent and incisive, and his manner of teaching made the learning of a difficult subject comparatively easy.

PROFESSOR F. O. BOWER
From the portrait by Sir William Orpen.

Botany is a branch of science which does not make a particularly ready appeal to the popular imagination; a botanist does not discover curious animals in untrodden jungles, nor does he discourse on themes of such magnitude as the speed of light or the temperature of the stars. Nothing theatrical is associated with a chair of Botany, and writings of a botanist are by no means sensational. But this year's President may be trusted to interest his great and representative audience as genuinely as any of his distinguished predecessors. Professor Bower will wear the blue ribbon of extra-academic science with as much distinction as any previous occupant of the Presidential Chair.

In the course of a long scientific career, the President has written several valuable works and monographs dealing with plant life. One of the earliest was a small but admirably arranged handbook to the botanical laboratory. No beginner in botany could have had a clearer guide to the microscopic structure of plant tissues. In the session of 1917-18 Dr. Bower and his colleague, Graham Kerr of zoological fame, delivered a course of lectures on "Sex and Heredity." These were afterwards published in 1919, and they form a valuable contribution to the physiology of reproduction in plants and animals. In the same year the President published in the "Pioneers of Progress" Series a short life of Joseph Dalton Hooker, the great English botanist so long at Kew. Dr. Bower has also written most acceptably for the non-scientific reader. He published in the *Glasgow Herald* a series of articles dealing with the relationships of plants to men, and collecting these in 1925, he published them as a separate volume, called "Plants and Men, or Essays on the Botany of Ordinary Life." The character of this interesting book will be understood from the following list of some of the subjects it deals with:—Meadow and pasture; woodland, moor and mountain; golf-links and playing fields; the sea shore; the flower garden; the kitchen garden; desert fruits; cereal grains; timber; twine; parasitism; the fungal habit; scavenging and

sanitation; man's dependence on the vegetable world; and, finally, man's influence on the vegetable world. The chapter on bacteria is particularly valuable, and the illustrations throughout the book are excellent.

Research on Ferns.

Much of the President's reputation as a botanist rests upon an elaborate and highly technical work dealing with the great group of the ferns (*Filicales*) which appeared at Cambridge in three volumes between 1923 and 1928. Dr. Bower has published many papers on the Ferns, both in the Philosophical Transactions of the Royal Society and in the "Annals of Botany." Another technical work, "The Botany of the Living Plant" (1919), is regarded by fellow botanists as an important contribution to their science. In the realm of scientific speculation, Professor Bower is known as the expounder of a hypothesis concerning the "Origin of a Land Flora" (1908). To this problem he has given much study, and it formed the subject of his "Hooker Memorial Lecture" in 1917 and of his "Huxley Memorial Lecture" in 1929.

To appreciate the theory fully one must, of course, have had some training in botany, but briefly the hypothesis is as follows: Originally plants were marine, and had what is called "alternation of generations," that is to say, between any two gametophytic phases a sporophytic phase intervened. The plants that live on the land are the land-living sporophytes, the gametophytic phase having become inconspicuous. Subsequently in certain algae, and particularly in the Archigoniatae, a sporophytic phase was interpolated in each life-cycle between the successive gametophytes. In land vegetation this latter phase has attained such preponderance that the original gametophyte has been overshadowed by it and virtually eliminated. The diploid plant-body, though secondary in its origin, now constitutes the vegetation of the land.

The President has been honoured by several universities and learned societies in this country and abroad. As far back as 1891 he was elected a Fellow of the Royal Society, on whose council he served in 1901 and 1902 and again from 1925 to 1927. In 1909, he was awarded the Royal Medal of the Royal Society in recognition of his valuable contributions to botany, both systematic and theoretical. In the same year he was honoured with the gold medal of the Linnaean Society, undoubtedly on account of his work, "The Origin of a Land Flora." Professor Bower has been President of the Royal Society of Edinburgh, and was the recipient of its Neill prize in 1926. His Cambridge Alma Mater conferred on him the degree of Scientiae Doctor (Sc.D.), a very carefully guarded honour, while from the Universities of Dublin and Sydney he has received the degree of D.Sc. He is also an LL.D. of Glasgow and Aberdeen Universities.

The President is a corresponding member of the Botanical Society of America, of the Royal Botanical Society of Belgium, of the Academy of Science of Munich and of the Royal Danish Society, an Honorary Member of the German Botanical Society, and a corresponding member of the Royal Academy of Turin. He has been three times President of the Section of Botany of the British Association, and has taken as the subject of his Presidential address to the whole Society the problem of "Size and Form in Plants." This topic, one of considerable interest to all biologists, forms the theme of a volume shortly to be published by the Macmillan Company. The President's zeal for Glasgow University did not cease with his resignation from office, for he continues even now to serve the interests of the Scottish university in more ways than one. Not long ago, Dr. Bower presided at an interesting gathering of the Glasgow University Club in London. His portrait was painted by Sir William Orpen in 1927, and appropriately hangs in Glasgow University.

Grand Canyon Expedition.

In the scientific study of the Grand Canyon, some of the most recent advances have concerned the extraordinary story of life of the past preserved in the geological strata Fossil plants and the traces of many extinct animals have been found in abundance in formations dating back approximately to the age of coal plants, or what is known as Permian time. There also were seen early examples of the great race of reptiles shown in many types of life as yet imperfectly known. Another discovery of much importance is represented by lowly types of plants discovered as fossils in rocks, the so-called Algonkian rocks, that represent one of the earliest periods from which remains of life have been obtained.

An American expedition has just returned from the Nankoweap Valley, an isolated and little known basin in the extreme north-eastern part of the Grand Canyon. The exposed rocks in this area are chiefly Algonkian. Because of their great age they are of special interest to those who are searching for evidence of ancient life. Dr. C E Resser, Curator of the United States National Museum, the leader of the expedition, reports that abundant evidence of aquatic plant life was discovered but no traces of animal life.

The Discovery of a Pyramid.

By Eduardo Noguera.

Translated from the Spanish by Professor A. S. Riggs.

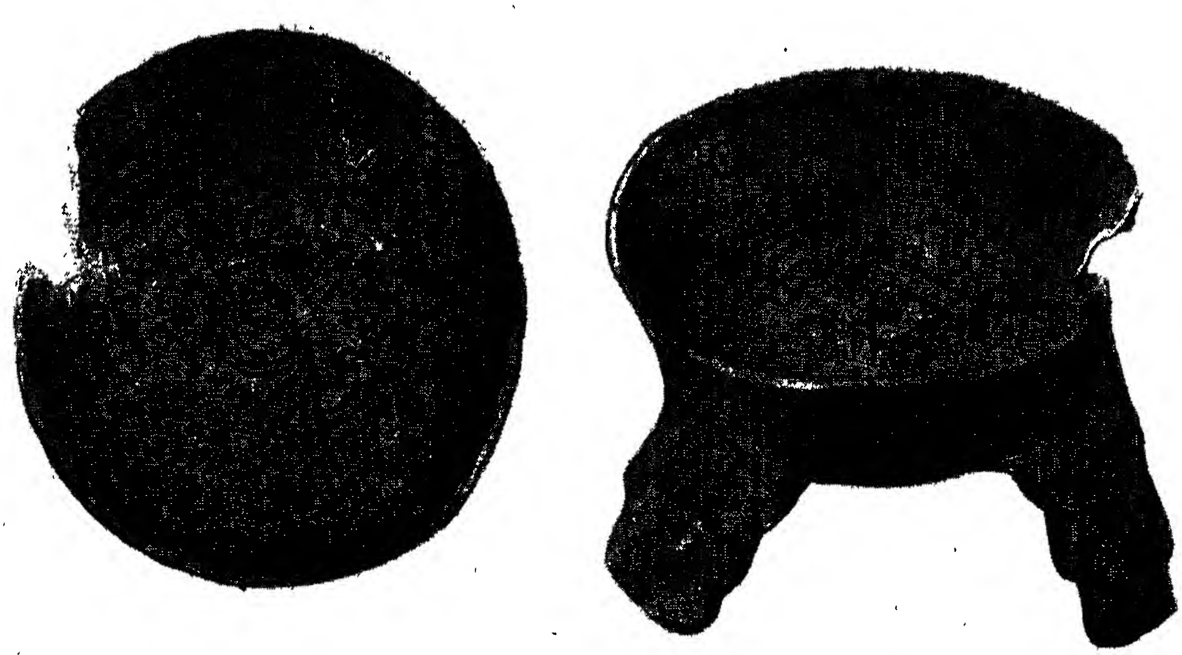
The discovery in Northern Mexico of the Pyramid of Tenayuca has thrown valuable light on the architecture of the Aztecs, a race which inhabited the country during the middle ages. Excavations have been conducted on an extensive scale during the past five years, and the district has proved an important field for archaeological research. Many ceramic fragments of artistic value were discovered.

THE most important archaeological discoveries made during recent years in Mexico have without doubt been those dealing with the Pyramid of Tenayuca, situated a short distance to the north of the City of Mexico.

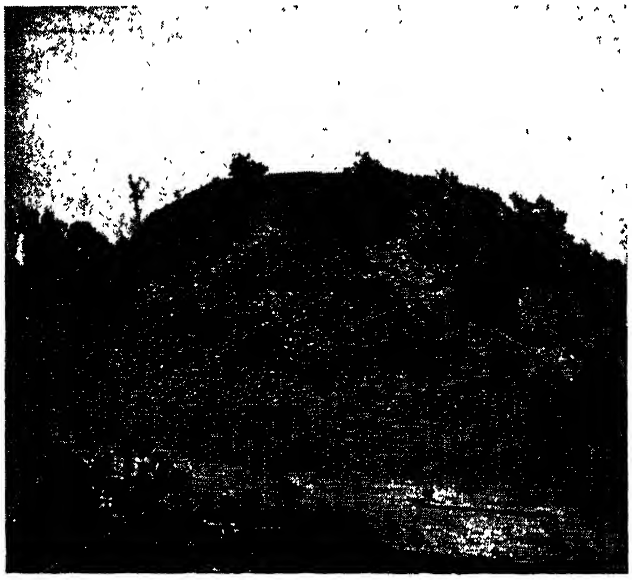
These discoveries have clearly demonstrated and confirmed the chief characteristics of the architecture peculiar to the Aztecs, who so valiantly succumbed to the invasion of the European in the sixteenth century. Hitherto little has been known of the architecture of this important people. The ancient Tenoxtitlán, the fortified capital of the Aztecs, was obliterated by the Spaniards in their reduction of the country and subsequent establishment of their dominion. Only a few isolated edifices escaped this wholesale destruction, thanks in part to the fact that they had been erected outside the confines of the city, in part because they had been built by the Nahua tribes who previously occupied the Valley of Mexico.

For five years, beginning in 1925, the work of exploring these monuments has gone steadily on. Only now is the combined work of repair and conservation at an end. Hand in hand with it has gone the study of the history of the pyramid, made possible by means of the inscriptions and sculptures upon it, the small fragments of ceramics and other minor objects, and by the written records left by the first Spanish missionaries, who obtained their information direct from the Indians themselves early in the days of the Conquest. The work of exploration and conservation was undertaken by the Archaeological De artment of the Mexican Government.

Before the work of excavation commenced the pyramid appeared much like a natural hill or mound, covered with scrubby vegetation, but its removal disclosed an exceedingly interesting monument concealing the debris of ages. The principal monument consists of a pyramid measuring



A DRINKING BOWL CARRYING SYMBOLIC DECORATIONS.
This style of motifs was found in many other representations, and is thought to be related with the religious beliefs of the people



BEFORE EXCAVATION.
The pyramid resembled a natural mound and was covered with scrubby vegetation. Its removal disclosed a monument rich with the debris of ages.

more than forty metres on each side and rising to a height of rather more than fifteen at the present time. Originally the height must have been considerably greater, since a large part has been destroyed by the natives of the region, who pulled out the splendidly hewn stones to use in their own structures.

The stairway ascends the western face of the pyramid. It consists of a double set of treads and risers, separated by a dividing mass of low masonry called an *alfarda*, which is a characteristic element of Aztec architecture. It is interesting to observe that many of the steps have carvings representing different symbols.

All this first construction conceals another edifice of greater antiquity, of which there remains in almost perfect condition an interior stone stair. Here, too, the steps are carved, as on the exterior; but in this case there appears a certain symmetry, which makes it clear that we are dealing with either a super-posi ion or that there may have been two different periods of construction. To both north and south of the pyramid, and at a distance of some eight metres from it, appear small platforms which may well represent altars, since before each we find beautiful, coiled serpents which indicate points in space. The serpent on the north thus points to the north-west, while its companion on the south side indicates the south-west. It has been thought that this arrangement and orientation was meant to convey the maximum separation of the points reached by the sun during winter and summer seasons.

Another important detail was the finding of a small platform at the foot of the masonry division of the exterior stairway. Within this we found a fresco representing crossed bones and human skulls richly ornamented. These motives are repeated on the exterior walls or sides of the platform, but they are carved in stone instead of being in fresco. Before concluding the excavation of the monument, it was considered essential to drive a tunnel through it, beginning on the east, to determine the number of interior structures there may have been and to ascertain the super-positions or amplifications of the edifice, besides definitely attributing each to its proper local culture. Two ancient edifices, much older than the pyramid itself, were encountered within it, representing four distinct epochs of construction or super-position.

Thanks to the discovery of this pyramid, it has been possible to classify the chief architectural characteristics of Aztec edifices. Done José Reygadas Vértiz, who conducted the excavations at Tenayuca, considers them briefly as follows :—

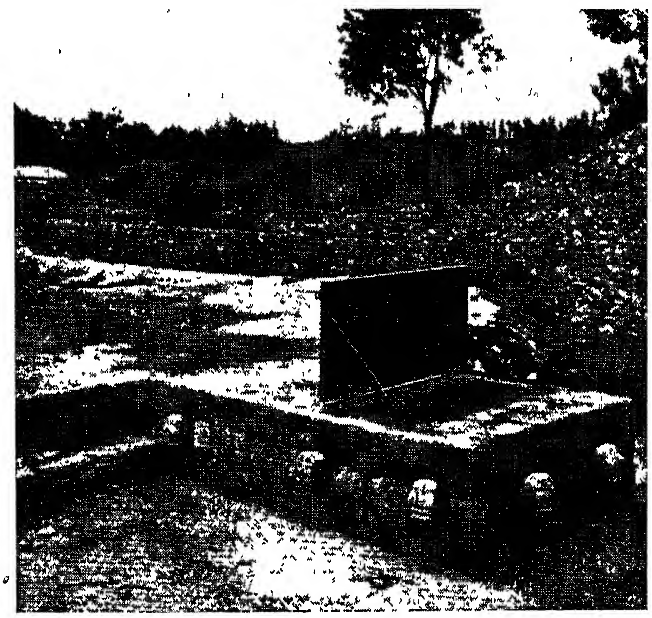
(i) Taluses, or slopes of abrupt inclination.
(ii) Decorative bosses or knobs upon the taluses.
(iii) Narrow spaces upon the taluses, not meant to be used as passage-ways or walks.
(iv) Stone stairways divided by double *alfardas* or low masonry partitions.
(v) The central *alfardas* present two changes of pitch of a determined height in such a manner as to form a small landing-stage.
(vi) Characteristic also of certain other cultures : super-position of two or more structures.

This discovery is important not only because of its

A YEAR LATER.
Numerous vases of great value were encountered and are here seen at the foot of the pyramid among piles of stone and human remains.

architectural significance, but also because the large number of small objects, especially ceramics, which invariably accompany this class of archaeological edifice, have served as a base for extended study. All the ceramic fragments were brought together and studied minutely. The resulting conclusions serve to corroborate much that history, as set down by the early missionaries, has told us about Tenayuca. I will not here enter into further details, since a complete account of these ruins is being prepared.

It is, however, possible to include in this short review those objects of most artistic value which were discovered at the foot of the platform which gives access to the exterior stairway. These were found mixed with human bones inside small cavities like sepulchres. One of the most interesting examples found represented a coyote, or perhaps a dog, in a seated position. By its zoomorphic form and because in one sense it constitutes a novelty among Aztec ceramics, it recalls similar specimens of Tarascan origin. The latter people manifested a distinct predilection for this class of figure. The hindpaws were very well executed, in contrast to the forepaws, which were scarcely more than indicated by light moulding. The head was an interesting piece of realism. The snout was extended, as is proper with this class of carnivores, the mouth being left sufficiently open to show the teeth. The tongue lolled out between the two canines, which curved downwards to meet the lower mandible. Instead of true ears, the figures carried two " earmuffs " or adornments, the left one being of the type known as *oyohualli*. From the posterior part of the top of the head opened the receiving aperture for the human ashes, the edges being extended and prolonged toward the rear. An oblique configuration of the eyes was another realistic detail.



THE FOOT OF THE PYRAMID.
One of the small platforms with skulls and bones sculptured on the exterior The trap door was built to protect the frescoes of the interior.

AN INCENSE BURNER.
Made of the finest clay, this perfumer is a perfect piece of craftsmanship. The triple supports of the base are decorated in deep incised reliefs.

Another funerial vase is a beautiful example of a perfumer or incense-burner, made of the finest clay, perfectly worked on the outside of a cherry-coloured base or slip. The triple supports of its base are decorated in deep incised reliefs which show eagles' heads and which also serve as rattles. The globular body of the censer carries decoration which is best described as lace or open work. It extends through the entire thickness of the wall in the form of circles. Alternate circles are perforated while the intermediate ones are in relief only, this being necessary for the solidity of the vase. The neck is almost horizontal, forming an acute angle with the body and the lip flares widely. The interior is neither well finished nor painted, and contained no calcined remains. A small drinking bowl was found, and is of interest chiefly because of its elaborate symbolic decoration. This style of motifs is to be found in other representations, which indubitably signifies some relation with the cult of the region and the religious beliefs of the people who constructed this monument.

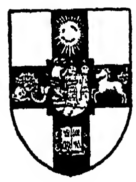
British Universities To-day : (7) Bristol.

By Thomas Loveday, M.A., LL.D.

Vice-Chancellor of the University of Bristol.

Resuming the review of British universities which was begun in DISCOVERY *last spring, our contributor shows how Bristol is notable for its rapid growth and the close connexions it has established with education generally in the west of England. The University enjoys the advantage of generous endowments.*

THE University of Bristol is twenty-one years old this year, but its roots go a little deeper into the past. The Bristol Medical School, itself the heir of a long tradition of medical teaching in the city, was established nearly a century ago; the Merchant Venturers Technical College, in which the faculty of engineering has its quarters, grew out of a trade school founded in 1856; and twenty years later came into being the University College which was destined to integrate these professional studies with those of pure science and the humanities in a larger whole. Some such unification as eventually took place was present to the minds of the promoters of the College from the outset; it was foreshadowed in a speech of Jowett which is still remembered; it was the clear idea of Percival, preaching that Bristol through its College, and eventually through its University, should be—as now is symbolized in stone by the great tower—" the lantern of the west." If, as has sometimes been said, the attitude of the public schools to the modern universities has been (at any rate until recent times) somewhat distant, let it be recorded on the other side that, if in any one man, it is in the inspired and inspiring vision of the great Headmaster of Clifton that the movement towards university education in Bristol had its origin.



Humble Beginnings.

The College began, of course, small, and was for many years poor in purse; but like the other provincial colleges of that time it was blessed in the services of very distinguished teachers, its three successive principals being Alfred Marshall, William Ramsay and Lloyd Morgan; it met a public need which its own exertions fostered; it was liberally aided and encouraged by Balliol and New College; and the increasing support of Bristol citizens, and especially of the family of Fry, gradually enlivened the demand for an autonomous university. In 1908 the gift of £100,000 by H. O. Wills (the founder of the University) made realization of the demand immediately possible; and on the joint application of the University College (with which the Medical School had been united in 1893) and the Society of Merchant Venturers, the charter was granted in the following year.

It is well known that the rapid growth of the University in the short period of its existence has been in great part due to the munificence of the founder's sons, who in addition to sums for endowment presented severally or jointly the new Memorial Buildings, the great physics laboratory, the Union buildings, both the halls for men, the playing fields, and other benefactions, amounting in all to over £1,000,000 in value. The larger buildings have been frequently described and depicted. Those who visit them should give a thought not only to the generosity of the donors and the architect's genius, but also to the devotion of the craftsmen who through years laboured to make every detail perfect in its kind. One of these craftsmen, carving oak, was asked by an onlooker how long he expected his work to last. " I don't know how long it's going to last, Sir," he replied at once, " but I'm making it to last for ever." Material beauty, so carefully designed and carefully wrought, is a precious influence in education, imperceptibly drawing the soul, as Plato taught, into conformity with the beauty of reason; and though the principle is trite, the rapidity of its exemplification was astonishing when undergraduates migrated from shabby huts into the new buildings. It should be added that these great gifts were so given and have been so administered that the maintenance of the fabric is no charge on the ordinary funds of the University.

The constitution of the University is similar to that of other modern universities and calls for no special comment, unless it be to note that non-professorial teachers are included not only on Boards of Faculty but also on the Senate by co-option and on the Council by election. Like all its fellows, the University of Bristol owes an incalculable debt to lay members of

Council, without whose unremitting care for its interests it could not have thriven nor now thrive. The cities of Bristol, Bath and Gloucester, and the counties of Gloucestershire, Somerset and Wilts, all aid the University financially and are represented on the Council; they constitute its special "province" except for agricultural advisory work, which extends also over Worcestershire and Monmouth.

Four Faculties.

There have been from the beginning four faculties, that of arts being now slightly the most numerous and engineering the smallest, whilst the number of students reading pure science is approximately the same as the number of those aiming at qualifications in medicine and dentistry. It is hoped that before long the present department of law may flourish into a faculty, and that a faculty of theology may also be established. To students reckoned in the several faculties must be added those training for a qualification as teachers. Of these in recent years the majority have been graduates reading for a Diploma in Education, but there have also been some women pursuing a two-year course of study for a certificate; no fresh entries for two-year courses are now accepted. The total number of students is about 950; the number tends to rise in a steady and manageable way.

The great bulk of the work within the faculties, in respect both of teaching and of research, however much it may in detail and in particular emphasis differ as between one university and another, is in general character alike everywhere, and so requires no detailed description. Special features at Bristol are largely the result of the policy which the University has adopted from the first of associating with itself institutions doing congruous work. With the faculty of arts there are connected two theological colleges in Bristol, one in Salisbury and one in Warminster, at which candidates for the B.A. degree who specialize in theological subjects can pursue part of their curriculum. Men reading for the B.Sc. degree in agriculture spend their first year and certain other periods later at Bristol, the rest of their time at the Royal Agricultural College, Cirencester, and on a selected farm. Women reading for the B.Sc. degree in domestic subjects spend three years on pure science at Bristol and one on its practical application at the Gloucestershire Training College of Domestic Science. In the faculty of medicine there has, of course, always been a very close connexion between the University and the hospitals of the city in which clinical studies are pursued, the two main hospitals being the Bristol Royal Infirmary and the Bristol General Hospital. Lastly, the faculty of engineering, which, as has been mentioned, is housed in the Merchant Venturers Technical College, was for many years entirely and is still in great part equipped and maintained by the ancient Society of Merchant Venturers, which in many ways has been a pioneer in educational work in Bristol.

The new main buildings of the University, which were opened by His Majesty the King in 1925, accommodate the administration and the faculty of arts, and the general and medical libraries. The scientific and medical departments, except physics and mathematics, are house in older buildings close by, the most recent being the chemical wing, opened in 1910. The chemical laboratories were very carefully designed and still serve their purpose excellently, but they are excelled in spaciousness by the new physics laboratory which crowns the Royal Fort Hill about a quarter of a mile away. This great institute was opened in 1927, and finds room for the department of mathematics as well as for experimental and theoretical physics, and the facilities in it for research have already attracted advanced students from the Continent, America and Australia, as well as from other parts of this country. Whilst several lines of research are at present pursued in it, investigation shows a tendency to concentrate round problems of molecular structure.

The Colston Society.

An institution of great value to the University is the Colston Research Society, the youngest of a number of societies which commemorate the philanthropic and educational zeal of Edward Colston. Founded in 1900 to aid the University College, it has since the inception of the University had for its aim the promotion of research within the University. It is an association of Bristol citizens which, like the other Colston societies, holds an annual dinner and makes an annual collection, the proceeds going entirely to aid research. Since 1900 the collections have amounted to over £15,000. Under the auspices of the Society also Bristol firms have from time to time provided research fellowships which have been held by graduates of the University. During the last two years the scope of the Society's activities has been enlarged by the receipt of capital sums to be held in trust, the income being devoted to aiding research, and it has been decided to use the income from one such gift in the first place to aid investigations into means of combating certain insect pests of fruit.

This application of the fund is an instance of the close ties between the University and the principal

industries of the area which it specially serves, agriculture and horticulture. Bristol itself is, of course, a large industrial as well as commercial centre, but (fortunately in these times) it is much less specialized industrially than most large towns. There is also a considerable variety of industrial works in the smaller towns of the area. But, taken as a whole, the district is predominantly agricultural, and in one way after another the University has succeeded in extending its work on behalf of agriculture. The association of the College at Cirencester, already mentioned, dates back to the foundation of the University, though the provision of degree courses is more recent. To the same date belongs the association of the National Fruit and Cider Institute, which soon developed into the Long Ashton Research Station.

Fruit Research.

The station does advisory work throughout the province, and is also the primary national centre for research into fruit culture and the practical treatment of plant diseases. Recently the work done there on spray fluids designed to destroy pests of fruit trees in the egg stage, has resulted in the production of a very effective egg-killing wash which is now manufactured on a large scale by spray fluid makers. Valuable results have also been reached in the last few years concerning the nutrition of fruit trees, and many other promising lines of work are constantly opening up. The original interest in cider-making still continues, and the marked improvement during recent years in the general quality of this increasingly popular beverage is largely due to the Station. Problems relating to willow-growing, an industry of some importance in Somerset, have also been under investigation for several years past.

Another institution for which the University is responsible is the Research Station for Fruit and Vegetable Preservation at Chipping Campden. This station came under its management after the end of the war, and has been of great assistance to the rapidly growing canning industry in the country. It is also responsible for holding courses in domestic preservation of fruit, and on this side has worked in close association with the Federation of Women's Institutes.

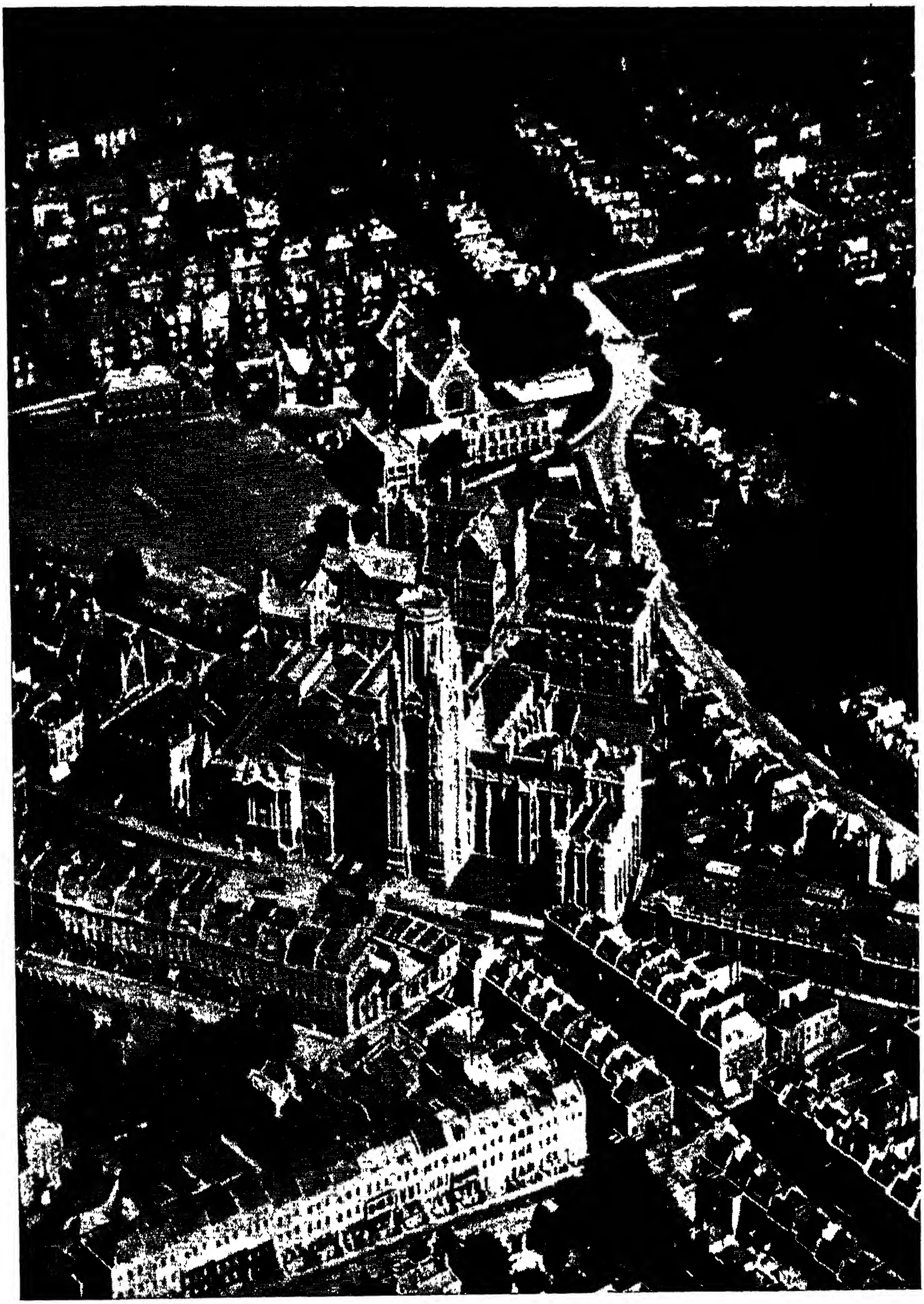
Provision having thus been made for fruit and horticulture, the University a few years ago decided to increase its work on behalf of general agriculture by appointing an agricultural information officer, who should keep practical farmers in touch with the results of scientific research directly valuable to them. This appointment, which was novel and made independently of the Ministry of Agriculture, aroused the Ministry's interest and led to the establishment of an agricultural advisory centre which is housed close to the University. The centre works in close touch with the county agricultural organizers and has grown very rapidly; calls for its assistance have grown with at least equal rapidity.

The absence from Bristol of industrialized environs brings other advantages, particularly in the ease with which students in such subjects as botany and geology may be brought quickly into touch with field work. The sea-board of the Bristol Channel, the moors of Mendip, and even the mud of the River Avon are a constant source of study by the botanists, whilst a valuable adjunct to this department is a small but well equipped garden at the very doors of the laboratory. Students of geology are fortunate in working in a district rich in geological interest, as indeed its scenic features would lead one to expect. It is no small advantage to have within walking distance the Avon Gorge, a unique section through carboniferous limestone and in itself an introduction to the subject of geology available to any freshman.

A considerable proportion of the students of the University are candidates for the teaching profession, and most of these are aided by grants from the Board of Education. (The Board's system of awarding grants has been much criticized of late, and Bristol has acted with certain other universities in suggesting a more flexible scheme.) The home of the department of education is the Royal Fort House, a beautiful eighteenth century building on the site of a fort, which was held and lost first by Colonel Fiennes for the Parliament and then by Prince Rupert for the King; the house is noted for its ceilings and friezes, and for its garden designed by Repton. It is chiefly in their graduate or professional diploma year that students work there, though during their academic studies they are in various ways brought into touch with the department, not least by having to join the choir.

Training Colleges.

Though it no longer accepts intending teachers for a two-year course, the University is kept in touch with the briefer system of training through the part it plays in the examination of training colleges. When the Board of Education recently decided to abandon its own examination for its certificate and asked the universities to organize local schemes, Bristol was one of the first to respond. An examining board was formed, styled the Western Joint Committee of the University and Training Colleges; six colleges came



[*Aerofilms*

BRISTOL UNIVERSITY FROM THE AIR.

into the scheme, and the second annual examination has just been completed. With the secondary schools of its area, again, the University keeps in close touch, partly by conducting examinations for the school certificate and higher certificate and partly by a conference which is held annually and attended by headmasters and headmistresses of secondary schools and representatives of local authorities as well as of the University.

All universities nowadays recognize a duty to those who, prevented from attending their ordinary courses, are yet desirous of and capable of profiting by teaching and discussions of university quality. This work of adult education, carried on partly by extension lectures and partly by tutorial classes, has grown rapidly in the Bristol province, and is now organized by a director of extra-mural studies. There are special difficulties in extending it through a large area not very thickly populated and not very well served by rapid transport. These difficulties have been met by the appointment of resident tutors, at present two in Somerset and one in Gloucestershire, who give their whole time to the work and, living in convenient central places, can reach even the most outlying villages. The tutors work in close co-operation with the rural community councils, and their efforts have resulted in a notable stimulation of intellectual interests in the rural districts. Extension lectures of the older type are organized under a joint board of the University and the University Colleges of Exeter and Southampton.

Collegiate Life.

Nothing in the current history of the modern universities of England is more remarkable than their gradual conversion to belief in the value of what may be called roughly collegiate life for undergraduates. Reading, which was never predominantly a local institution, maintained this faith from the outset, and so, of course, did the comparatively ancient University of Durham; but the others, originating in colleges designed to serve primarily a particular city, have been slow in facing the problem presented by students who come from a distance, and were long content, at any rate as regards the men, to allow them to live in lodgings, a practice which often leads to under-feeding and which is apt to produce the virtue of self-reliance distempered by a marked angularity. Women students, it was allowed, deserved or required more consideration, but it was rather to secure their parents' approval than because common residence was thought good for themselves that hostels were provided even for them; and for men little was done for a long time, except here and there by some religious denomination.

Bristol has been in this matter a little in advance of most of its fellows, and naturally so, since the problem has here presented itself more urgently owing to the size of the University's province, and the scattered distribution of the population. The proportion of students living at home is markedly below the average. About the time of the foundation of the University there was presented as a hall for women a famous old house in Clifton, once the home of Dr. Addington Symonds, and like the Royal Fort House noted both for its eighteenth century decorations and for its gardens. To this was added subsequently a neighbouring house, so that this hall, together with some smaller hostels shortly to be merged in a second large hall now in process of construction, accommodates all the undergraduate women who are not living with parents or near relations. For many years the men fared less well. There was indeed a single hall for men, but it was not well situated, nor could it meet the demand for rooms. More recently, however, gifts to which reference has already been made, have radically altered this unsatisfactory state of affairs, and the University now possesses two excellent halls, one an old Clifton house, holding about thirty-five men, the other (known as Wills Hall) a beautiful quadrangular building situated in an estate of over 20 acres, and containing 150 residents. To the Wills Hall there has quite recently been made the additional gift of a chapel. All undergraduate men, not living at home, have now to spend so much of their time as may be ordered in a hall. As numbers grow, residential accommodation will have to be still further increased, for it can safely be prophesied that except for medical students in their years of clinical study and other special cases, the rule requiring residence in a hall will be firmly maintained.

The Union.

It is interesting to notice that the men living at home or in registered lodgings have recently determined to achieve for themselves such benefits of community life as may be practicable by organizing themselves into a society which they have called the Haldane Society, in memory of the late Chancellor to whose guidance the University owes so much. The headquarters of this Society, as of all other undergraduate societies, is in the Union, which has for its habitation the Victoria Rooms, long the Assembly Rooms of Clifton. This handsome building contains, in addition to a refectory and common-rooms, a large hall with a stage and an organ.

(Concluded on page 317.)

Atlantic Transport by Air.

By J. L. Nayler, M.A., F.R.Ae.S.

Secretary of the Aeronautical Research Committee.

The record flight of the R. 100 *raises the question how soon air transport to America will become a commercial proposition. Less than one hundred years ago, addressing the British Association at Bristol, a speaker said that a steamship would never be able to carry enough coal to allow it to cross the Atlantic* !

THE Atlantic has been crossed many times by air and up to the end of July, 1930, more than 200 persons have made this flight. It is but reasonable to assume that just as the first ocean crossings were in small parties so also will it be the case with air crossings; to obtain a proportional improvement the reader will not, howe er, expect a similar lapse of more than two centuries between the voyage of the *Mayflower* and that of the first steamship. Before we delve too deeply into the future we will look briefly at the feats already accomplished. It will be convenient to consider alternately the use of airships (buoyant craft) on the one hand and of heavier-than-air (dynamic) craft on the other.

Three Factors.

H.M. Airship R. 34 with 34 persons on board crossed and recrossed the Atlantic in 1919 without much preparation. She left East Fortune before dawn on 2nd July, and after encountering much bad weather on the latter part of the flight reached New York after a journey lasting just over 108 hours, where, by first landing by parachute one of her crew who directed operations, an arrangement of wires from the ground to the ship was prepared so that the ship could be moored in what might be termed mid-air (see Fig. 2). This method of mooring is always possible in an emergency. The airship took on board new stocks of fuel, ballast and food and returned to Pulham, Norfolk, in the flying time of three minutes over 75 hours. This brief recital of facts brings out immediately three things:—(1) the much shorter time taken on the return route, which implies a good knowledge of the weather; (2) the need of careful navigation; and (3) the necessity for a ground organization to deal with large airships if they are to be used extensively for passengers and for transportation of goods. As regards (1), aircraft are in many senses more dependent on the weather than modern liners, but less so than the old sailing vessels.

Since the year 1919 the Atlantic has been crossed several times by airship, and the Graf Zeppelin has made the journey on several occasions. It is significant that her East to West crossings have been via the Azores and over the southern part of the North Atlantic while the return journeys were roughly along the shipping route. Amongst these must be reckoned that during her historic flight round the world when she flew a total of 21,500 miles in a time (including stops) of 21 days 7½ hours, and made one crossing, that of the Pacific Ocean from Tokio to Los Angeles, of 5,400 miles, which is much greater than the distance normally flown in an Atlantic crossing.

Let us now recall crossings made in seaplanes and aeroplanes. The American Navy used three flying boats, N.C. 1, N.C. 3 and N.C. 4, to fly from Trepassey Bay, Newfoundland, to the Azores on 16th May, 1919. This flight was one of a series of hops with stoppages for refuelling and repairs. The first direct flight between America and Europe was that of the late Sir John Alcock and Sir A. Whitten Brown who flew in a Vickers' Vimy twin-engine biplane from Newfoundland to North-west Ireland in 16 hours 12 minutes, on the 14th June, 1919, the same year in which H.M. Airship R. 34 made the double crossing a few weeks later.

Spare Engines.

Many similar single crossings have been made, including the famous (and first solo) flight of Charles Lindbergh in a Ryan monoplane on 20th May, 1927, from New York to Paris without a stop. It must for our present purpose be, however, remembered that he was the seventieth person to fly the Atlantic Ocean. Many unsuccessful flights followed which were accompanied by loss of life, and so took from other successful flights some of their glamour. All such crossings by dynamic aircraft are dependent upon the engine running without stopping for a large number of hours and, on this account, the latest flights have been made in three-engined aeroplanes, which are capable of flying with two engines only.

All the above had a prevalent wind in their favour and an extensive coastline normal to their direction of flight. The reverse is the case for an East to West

crossing, for the prevailing wind is then a head wind and the coast to the south falls rapidly away and to the north (Labrador), is inhospitable. For these two reasons, a smaller number of attempts have been made to cross the Atlantic in this direction and very few have been attended with success. The Americans in their "Round the World Flight" in Douglas aeroplanes favoured the northern route via Iceland and Greenland. Baron von Huenefeld and Captains Koehl and Fitzmaurice in a three-engined Junkers monoplane made the direct flight from Baldonnel, Ireland, to Greenly Island, Labrador, on the 12th April, 1928, covering 2,070 miles in 37 hours. Quite recently a second direct flight was made by Captain Kingsford Smith in a three-engined Fokker aeroplane, the "Southern Cross," from Dublin to Harbour Grace, Newfoundland, taking a little less than 32 hours. Both the latter grumbled at their compasses and neither had much spare fuel for continuing the flight. The former were fortunate in landing at a place not too distant from civilization and the latter in having wireless by whose aid the aerodrome at Harbour Grace was located after two or three hours flying around in a fog.

This brief recital of facts clearly brings out the necessity for increasing scientific knowledge to solve certain problems. As before, there is an acute need for better knowledge of the weather conditions and for satisfactory navigation. In addition we observe that on the West to East flights there is some margin in the fuel load that can be carried by present-day aeroplanes, which load might be replaced by passengers or goods; but in the reverse direction the safety line is nearly approached.

Two ways of getting over the last difficulty have been put forward and both have as their basis a reduction of the length of the hop, or the distance between landings. Both would need more ground organization than is at present in existence. The British Government are prospecting the northern route via Iceland which involves no sea flight longer than 300 miles and introduces certain subsidiary problems which we will mention. The other solution is that of floating islands in mid-Atlantic (see Fig. 4), where seaplanes and aeroplanes can land to refuel and, if necessary, to refit. The depth of the Atlantic is such that fixed islands are not a feasible proposition, and whether the sum of two or three million pounds estimated as required for a floating island can be found to carry out what will be a gigantic experiment remains to be seen when the cross Atlantic air traffic is of sufficient volume to warrant its trial. There remains the southern route via Spain and the Azores, which is very much longer than the Iceland route as the latter lies near a great Circle between Great Britain and central Canada (see Fig. 1).

As already mentioned, a knowledge of the weather conditions is essential for both types of aircraft. In the case of airships, it is possible to steer so as to get assistance from the wind. For flights from Europe it is necessary to go south to the Azores to find a prevailing wind from East to West. By the direct route advantage can be taken of the cyclone's rotation. A depression formed in the Atlantic proceeds roughly along the course of the Gulf Stream and has a velocity as a whole in that direction, while at the same time rotating in a counter-clockwise sense. Consequently airships fly on the northern edge of a depression when going West and on the southern edge when travelling East It is, however, essential to know where the cyclones are and in what direction they are travelling. During an early flight of the Graf Zeppelin between the Azores and Bermuda the Captain received by wireless a weather map which was, however, faulty in certain respects and resulted in his meeting unexpectedly a severe down current that damaged one of the horizontal tail surfaces. With the spread of meteorological knowledge and the aid of reports that are available from the shipping on the Atlantic routes a better weather map can be made of the direct route, and it is maps of this part of the ocean which were successfully transmitted by wireless to R. 100 during her recent voyage. It is difficult to see how at present aeroplanes can carry the necessary weight of apparatus for similar reception, and they would therefore need to rely on ordinary wireless reception of reports sent to them. Given better knowledge an aeroplane might with advantage alter its height of flight to get more favourable winds,

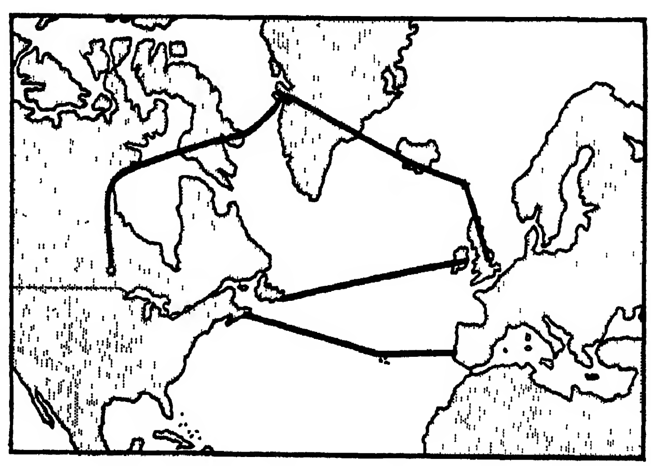


Fig. 1.
MAP OF THE ATLANTIC ROUTES.
Uppermost is the proposed Arctic route to Canada; the middle and lower lines represent the direct route from Ireland to Newfoundland, and the southern (Spain-Azores) route.

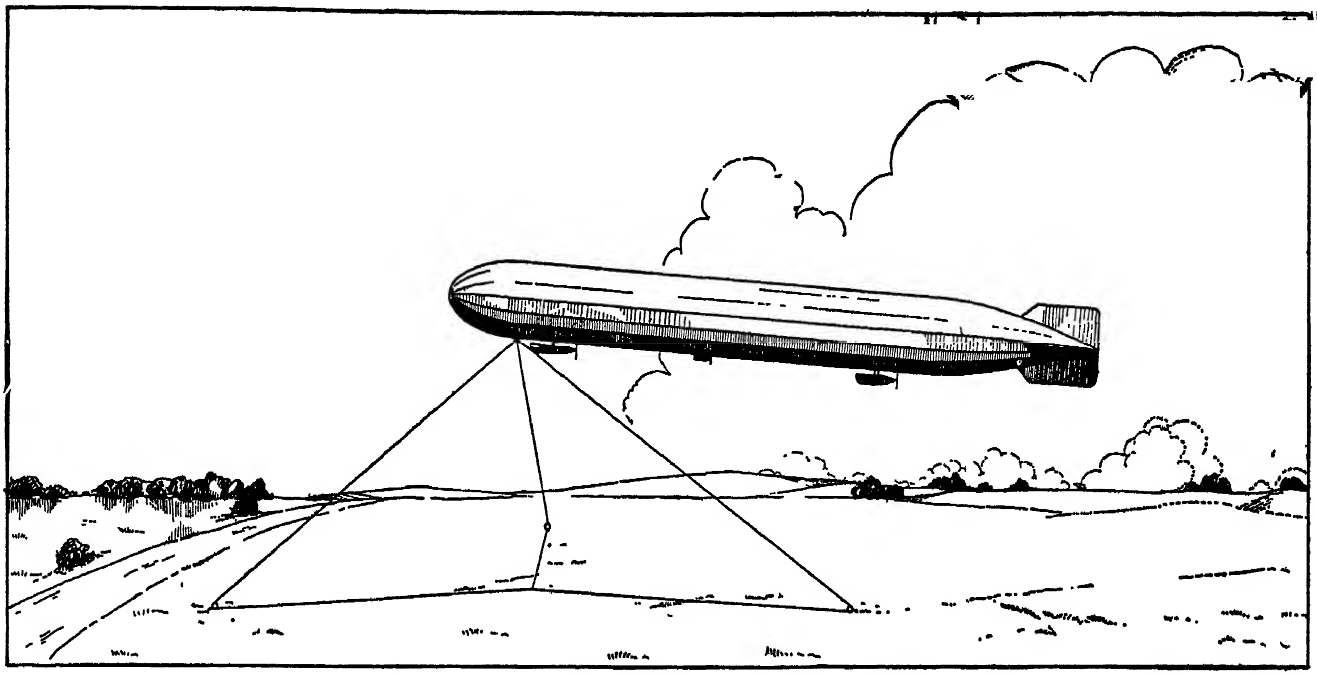


FIG. 2.
TEMPORARY ARRANGEMENT OF GROUND WIRES FOR MOORING AN AIRSHIP.

and in this respect has some advantage over the airship where large changes of level are avoided to minimize the consequent use of ballast or the necessity for valving gas, to adjust the total buoyancy of the airship to the changed conditions.

In the direct East to West route a real difficulty of the Atlantic crossing is the fog bank so frequently present near the Newfoundland coast, a loss of visibility resulting which may not be of such importance to the airship with its greater range and its ability to hover over a given spot without expenditure of fuel; the dynamic craft has, however, to find a landing place within a very limited time, and for this reason the northern route via Iceland is favoured by some authorities since the Great Circle (shortest) route from the North of Scotland to Winnipeg avoids the whole of this fog area.

The northernmost route brings other difficulties to the fore as the Ice Cap of Greenland is some 7,000-9,000 feet above sea level, necessitating a climb to that height and flight over most inhospitable country, though so far as data are available the general weather conditions appear to be satisfactory.

Associated with all flights over long distances and whatever the weather conditions is the problem of accurate navigation. An aircraft flies in the air, perhaps at first sight an unnecessary remark to make, but because of this fact its path relative to the earth's surface is compounded of its speed through the air and the speed and direction of the wind over sea or ground. Wind speeds are a large percentage of the speed of aircraft, and a much greater percentage than that of the tides on the sea are of the speed of marine craft. It is, therefore, most important for an air navigator to know the amount of his drift, and this he can estimate by various means. He knows his air speed from an instrument carried on the aircraft, so that if he knows his angle of drift he can calculate the course he has to set by compass. Over land, observation is made of some prominent object on the ground, whose direction of movement relative to a fixed line parallel to the centre line of the aircraft can be found by setting a bar so that the object moves along it. Various types of drift indicators have been designed which all embody this principle, and by two such measurements with the aircraft flying on two compass settings at a large angle to each other (45° to 90°) an absolute calculation of speed is possible. A moving line of beads in an instrument has likewise been used to measure directly the ground speed against some prominent fixed object. When over water, a flare is dropped and used in the same way as the fixed object.

Lindbergh, during his flight, took observations from time to time of the direction of the sea waves, which were a measure of the wind direction at sea level, and he was fortunate in having almost constant wind conditions throughout his flight. Whitten Brown was not so fortunate as the weather was changeable during the crossing. He carried a sextant and was able in mid-Atlantic to get a few readings from observation of the sun, the mean of which readings had little error, so that he corrected the compass course and Alcock and he made land on the north-west coast

of Ireland. The sextant cannot, however, be regarded as a suitable instrument for use on aeroplanes owing to the unsteadiness of the platform from which the readings have to be taken and the uncertainty of the horizon—artificial or real—which is used by the operator.

With the advent of directional wireless there seems to be little doubt that future aerial navigation over long distances will be by its aid. Even during the war the Zeppelins sent out signals which were picked up by German stations, who then 'phoned to the airships their positions. Similar means were adopted by Kingsford Smith to locate his aerodrome in Newfoundland during this summer's East to West flight, but the method is unsatisfactory. There seems to be no reason why airships at any rate should not carry directional wireless, as British ships must carry instruments of this kind sufficiently reliable to determine the direction of thunderstorms with the intention of avoiding such disturbed atmospheric areas. The transatlantic dynamic aircraft will, on the other hand, probably depend on a means similar to that under extensive trial on the air mail routes in the United States of America.

As at present arranged there seems to be no reason why the American scheme should not be extended for use over much greater distances and so adapted for crossing the Atlantic. A scheme was already working between Boston, Chicago and Omaha in the spring of 1929. Wireless signals from directional beams are heard in the pilot's cockpit so that he can tell when he deviates from the line joining two stations. By the visual method a system of coloured lights shows whether the aircraft is to the right or left of the course. In the aural method, which seems to be preferred, wireless signals of "Dash-Dot" representing the letter "N" and "Dot-Dash" representing the letter "A" are sent out in alternate quadrants (see Fig. 3) for stations 100 miles apart. On the line for the station the pilot has a mixture of the signals which sounds to him as a series of dashes, and if he wanders from the direct path he will hear either "N" or "A." The scheme outlined for the country is arranged on the 285-350 kilocycle band of waves. Complementary with the scheme is a weather transmission schedule from the same wireless stations originally sent out every half-hour, and now at shorter intervals. By the use of special ships or "seadromes" (see below), there seems to be no reason why similar schemes should not be adopted if there should be a sufficient volume of air traffic across the Atlantic.

Having directed the aircraft to its destination there remains the difficulty of landing, a difficulty not yet wholly solved for conditions of bad visibility. With the aid of the wireless telephone a pilot can be informed of the barometric pressure on the ground and so know roughly from his own instrument his height above the aerodrome—which he has previously located by wireless. Neon beams have been found efficient for

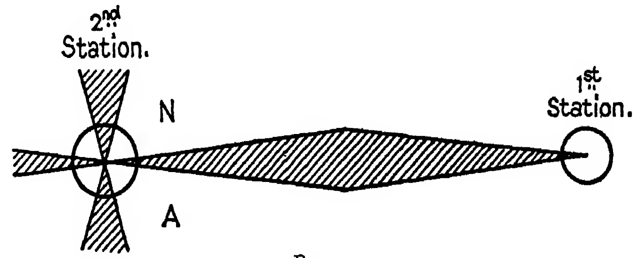


Fig. 3.
WIRELESS SIGNAL SYSTEM FOR DIRECTING AIRCRAFT

landing in most weather conditions at Croydon aerodrome, but whether they would be equally efficacious in a Newfoundland fog is not known. As already reported in *Discovery* (December, 1929), Lieut. Doolittle, working for the Daniel Guggenheim Fund for the Promotion of Aeronautics, has made successful blind flights to and from a given aerodrome using a very sensitive altimeter; but it seems doubtful whether this would have value for use after a transatlantic crossing. A wireless "marker beacon" seems more promising, and with its aid the crossing of a definite vertical plane can be registered or flight made down a definite "wireless lane" straight on to an aerodrome or to a mooring mast.

From what has been said the reader will have realized that in most conditions of weather the transatlantic route is both possible and feasible for lighter- and heavier-than-air craft. There remains the question of ground organization. The experience with mooring masts has already shown that they are a practical proposition for airships, since R. 100 and R. 101 have been moored out at Cardington, Bedford, for long periods under all types of weather. Such a mast has already been erected and used at St. Hubert airport, Montreal, for the flight of R. 100, and it enables passengers and goods to be taken by a lift from the ground to and from the top of the mast and thus into the airship. Arrangements for refuelling and taking on of ballast are also made via the mast. In fact, the airship problem appears to be on a satisfactory basis.

The ground organization for dynamic craft is not in such a happy position. The British Arctic air route expedition has as a consequence been sent out to carry through an investigation expected to last about two years. The route contemplated from London to

Winnipeg will be roughly as follows :—700 miles to a harbour on the coast of Sutherland or Caithness; a lap of 300 miles over the Orkneys to Thorshaven in the north of the Faroe Islands; 500 miles to Rejkjavik in Iceland, of which about the last 200 miles would be overland; 300 more miles of sea separates Iceland from Greenland, where a landing might be made North of the fog belt around Newfoundland, which extends nearly to 65°N. latitude; an ice cap with a height of 7,000-9,000 feet separates the east from the west coast of Greenland, a distance of 450 miles to Disko Island, which has been proposed as a base; another 400 miles, including about 200 miles across Davis Strait brings the route to a post of the Hudson Bay Company, distant 320 miles along the coast to Fort Churchill; here there is a considerable air traffic of surveyors to and from Winnipeg. In all, the route outlined is about 4,000 miles by air from London to Winnipeg, a distance at present covered by water and rail in twelve to thirteen days. If the route is to be continued to New York, a preference might be shown for proceeding south along the Greenland coast and past Newfoundland, the route taken by the Douglas planes when they flew round the world.

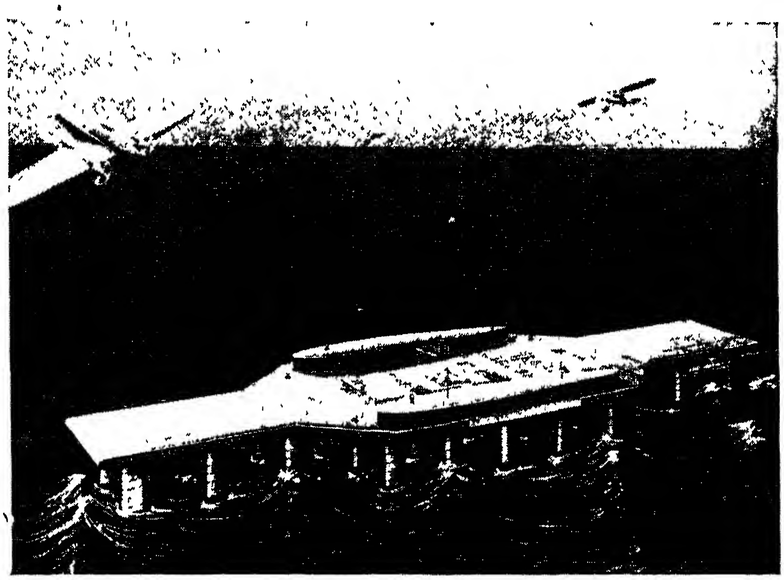


Fig. 4.
FLOATING "SEADROME" FOR OCEAN AIR ROUTES
A scheme for the establishment of floating aerodromes is already planned, the design here illustrated being the work of Mr Edward Armstrong

This Arctic route does not involve a sea journey of more than 300 miles as compared with the 1,890 miles direct of the first historic flight. Even if 500 miles is the normal stage, the saving in fuel weight could be utilized for transport of passengers or goods Kingsford Smith used in his East to West flight almost all of 450 gallons of petrol; so that the saving of more than 2,000 lbs. weight could be devoted to a paying load. Much of this Arctic route remains unexplored, and for part thereof during the winter, the hours of daylight would be few. Nevertheless, it holds out considerable possibilities, using alternately aeroplanes, seaplanes and aeroplanes with ski undercarriages.

The alternative of the "seadrome" cannot be entirely dismissed. Aeroplanes have frequently landed on and taken off from liners at the two ends of an Atlantic voyage, so that there is no unsurmountable obstacle in aircraft using a seaborne platform. The seadromes would have a deck of (say) 1,200 feet in length and be floated about 100 feet above mean sea level, being supported by a system of anchorage consisting of weights sunk to a considerable depth. There is the question of their original cost and that of maintenance, and they would need to be kept from drifting too far from their original site. A scheme for their establishment has already been thought out in considerable detail (see Fig. 4). With their use or by a well-established Arctic route with flights not exceeding 500 miles, air transport by dynamic craft is as feasible a proposition as journey by air throughout Europe or within the United States. Aeroplanes may also be used to supplement airship traffic, and arrangements have been made in the large airships now under construction in the United States to house five aeroplanes on board.

In conclusion, we may revert once more to the airship. R. 100 has a top speed of 80 m.p.h. and has been designed to carry about 100 passengers and 10 tons of mails. With a steady head wind of 20 m.p.h. she could be expected to cross from Dublin to Newfoundland within two days, and she has already flown from the mast near Bedford to that near Montreal in just over three days. On the return journey her maximum speed would be 100 m.p.h. (instead of 60) with her mean cruising speed likewise increased to result in a great decrease in the time of travel. Moreover, the Graf Zeppelin, a smaller ship, averaged round the world a speed of 78 miles per hour. R. 101 has with its new bay a greater paying load capacity and with more powerful engines should be even a better proposition for air transport. In fact, given the necessary traffic loads, there does not seem to be any reason why Atlantic transport by airship should not become a practical proposition right away.

Open-Air Museums: A Plea for England.

By E. N. Fallaize.

Honorary Secretary, Royal Anthropological Institute.

It was announced last month that proposals for a Folk Museum are having the attention of the Government. The establishment of such an institution, designed to display the buildings of earlier periods and their contents, is a matter of urgency owing to the rapid changes taking place in the English countryside.

A CYNICAL view of the conduct of public life—at one time, perhaps, more justifiable than at the present day—looked upon a Royal Commission as a convenient method of shelving embarrassing questions in relation to which action was inexpedient or inopportune. It is devoutly to be hoped that the recommendations of the Royal Commission on our National Collections and Museums will not share the fate of the reports of so many of its predecessors.

Educative Value.

The two reports of the Museums Commission constitute one of the most important public pronouncements in relation to the advancement of scientific knowledge among the general public which has been issued for many years. For the average individual a well arranged and properly organized museum is the greatest educative medium in the subjects which come within its scope; for many it is the only means by which they are likely to obtain any acquaintance with the most recent advances in research in those branches of science which are susceptible of museum display.

Those who are best acquainted with the conditions in which our museums function are well aware how few, if any, of the recommendations of the Royal Commission are such that they can be ignored even for the time being. Where so much is urgent there is danger, especially in the present financial condition of the country, that any recommendation for a new type of institution may be set aside while the claims and needs of existing organizations have to be considered. To whatever degree this may be conceded to present circumstances, there is one suggestion which it would be unwise, even hazardous, to set aside for consideration at some future but indeterminate occasion in the hope that it will be more opportune than at the present. The Commission reports strongly in favour of the institution of a national folk museum. It realizes the urgency of the proposal; and its recommendation cannot be too emphatically endorsed.

It is a remarkable thing, but at the same time one that is not difficult to understand, that the small group of enthusiasts who, in the latter part of the nineteenth century revived and organized interest in the life and thought of the peasant population of Britain—the movement which led to the foundation of the Folk-Lore Society, of which the jubilee was celebrated two years ago—should not have succeeded in arousing interest in an equal degree in the preservation and study of the humbler types of material culture in these islands. Their opportunities were far greater than ours to-day; but although a taste was stimulated among collectors and dilletanti for the more or less indiscriminate acquisition of certain classes of objects—pewters, brasses and the like, and many valuable records were made of implements and utensils of the more archaic types surviving in the remoter parts of Britain—very little was done in the way of systematic and scientific study. Yet how much might have been done can be seen from the success which some years later followed the efforts of Cecil Sharp and his colleagues in preserving folk-song and folk-dance at the moment when these forms of peasant art were in danger of complete extinction.

A Revolutionary Change.

To-day we stand in a position very different from that of the pioneers of the Folk-Lore Society. Fifty years ago, it is true, a wave of agricultural depression was driving the rural population to the towns, and the next twenty or twenty-five years saw a great increase in the introduction of machinery in substitution for manual labour and the traditional implements of agriculture. But within the present century social England, especially in the rural districts, has undergone a change which seems likely to prove as great and as revolutionary as that which took place in the two hundred years between the reigns of Edward III and Elizabeth Since the war changes in conditions have accelerated rapidly. Facilities for rapid transport, the break-up of great estates, schemes

of public housing and small-holdings, together with changes in various directions affecting agricultural methods and policy, are rapidly and profoundly affecting the countryside, sweeping away much that was traditional and characteristic in English rural life while tending to produce one general and uniform quality and type in culture even more effectually than, as some believe, wireless broadcasting will eliminate local peculiarities of diction and pronunciation.

It would be idle to regard the social and economic changes of to-day as anything but inevitable; and it would be equally unprofitable to adopt the attitude of the mere reactionary towards them however much the destruction of tradition they entail may be deplored. A sense of perspective in history teaches us that destruction is as essential to progress as construction. The present generation, however, has become self-conscious. It realizes more fully the consequences of its actions. If it is pulling down more rapidly than ever before in our history, it is beginning to appreciate more clearly that natural beauty and historic associations have claims which should be taken into account and at times even be allowed to outweigh economic considerations. The rapidity and nature of the changes taking place have quickened the public conscience to scrutinize closely any proposal for development in either country or town, whether put forward by public authority or private individual. The number of sites which have recently been handed over to the National Trust, the agitation to prevent the spoliation of Hadrian's Wall, and the subsequent pressure to enlarge the powers under the Acts for the Preservation of Ancient Monuments, all alike are signs of a healthy growth of public opinion on the side of the conservation of the natural beauties of the countryside and of the relics of historic Britain.

A DANISH FOLK MUSEUM.

A corner of the "Old Town" museum at Aarhus, which includes an ancient water-mill. (Photograph by courtesy of the *Museums Journal*)

More immediately germane to the issue of a folk museum raised by the Royal Commission is the work which has been initiated by the Royal Society of Arts for the preservation of typical ancient dwellings of the humbler type in Great Britain. Anyone who has wandered in the remoter districts of England—in the Cotswolds, for instance—is well aware that nothing is more illuminating, more revelatory of the geographical, social and economic conditions of the people in the past than these ancient dwellings surviving in the natural surroundings of which they are essentially the product and where they have endured changing conditions through the ages down to the present day. Even within relatively a short distance of London can still be seen houses of wattle and daub of the plan typical in the mediaeval English village. Variations in plan, structure and material according to local conditions are vanishing rapidly under sanitary requirements and the spread of the public authorities' model dwellings. That local types which bear the record of past ages should be allowed to be swept away entirely is a calamity involving an irreparable loss to the social history of England which every effort should be made to avert.

While the preservation of a site of great natural beauty appeals to the aesthetic sense of the public, and the conservation of a monument of high antiquity, a historic building or even a peasant's cottage may appeal to its imagination, the expenditure of time and money on rescuing from destruction and oblivion the objects, of no great aesthetic merit or intrinsic value, once in everyday use among the country folk may seem nothing more than a concession to a spirit of mere antiquarianism. Exhibits shown in isolation without relation to their environment and use would only serve to confirm this view. Yet, whereas collections of the armour, dress, weapons, furniture, utensils and other domestic appliances illustrate and demonstrate more or less adequately the social life and arts of the upper classes of early England, the

arts and industries of the peasant population are poorly represented. As a record of social and economic history they are not less but even more worthy of attention. From many sources we can gather an idea of what manner of life was that of the upper classes. Of the peasants we know relatively little; and it is illuminating to see and handle the implements and utensils of which they made use in their daily lives. Some have survived practically unaltered perhaps for hundreds of years. They may in a year or two utterly vanish and be known to posterity only by hearsay or from a chance illustration. Many, indeed, have already gone. How much, indeed, would be our knowledge of English mediaeval agriculture and husbandry and of the mediaeval recreations of the people if the Bedford Psalter and Book of Hours and other illuminated manuscripts in the British Museum had not been preserved to us. Yet in a few years time, unless measures are taken very soon, we shall know less of the arts and crafts of our ancestors in the times leading up to the age of machinery than we know of the Middle Ages.

Scope and Objects.

Perhaps enough has been said to mark the serious gap in our national collections due to the absence of any representative assembly, as opposed to isolated objects, illustrative of the life and culture of the people in the past. It may be an advantage at this point to define a little more precisely what should be the scope of such a museum in space, time and character.

From the point of view of the anthropologist and the social historian, it may seem neither consistent nor convenient to make an arbitrary distinction between upper classes and peasant such as is suggested by the emphasis laid here upon peasants arts and industries. While admitting the justice of the criticism, the distinction is valid if only as a matter of practical convenience. In the recently instituted folk-galleries of the National Museum of Wales at Cardiff, it is true, a valuable exhibit of eighteenth century garments of the upper classes recently donated to the collections is shown, and in some of the large culture museums on the Continent objects illustrating the life of all grades of society are shown side by side. But in general the considerations of space must determine. In England, the culture of the upper classes of mediaeval and later England is already adequately represented in our national collections. As a matter of practical convenience, therefore, it is advisable that the museum should be confined to the folk entirely. It should not go beyond the arts and industries of the peasant and what would now be called the lower middle classes—the industrial and lower commercial groups.

As a part of a larger unit, unless economy of space is no consideration—a condition hardly probable—the collections will almost inevitably be cramped If the full educative and scientific value of such a museum as is suggested is to be obtained, it is essential that the exhibits should be seen in their natural relation and in their proper environment. Thus in the National Museum of Wales compartments have been arranged in which are reproduced a kitchen, a bedroom or the like to represent the corresponding room in the typical Welsh house. But even at Cardiff it must be admitted that the lack of adequate space for the proper display of the exhibits is only too apparent.

Again, the question of space has a bearing upon the time factor. Period enters into the display of peasant culture almost as much as in the display of furniture or other material of upper class culture, even though in the earlier centuries phases may not be so numerous or well marked as at a later date. The number of divisions on the time scale to be represented unless space is ample may otherwise have to be determined by the amount of space available rather than by type.

On the Continent, notably in Sweden, Holland and Denmark, where special attention has been devoted to the question of folk museums, or rather museums for the exhibition of objects illustrating the national culture, a special type of museum has been evolved. These are generally known in England as "open-air" museums, though that is hardly a quite accurate designation. The essential feature of this type of museum is that the exhibits are not housed in one building, but in separate buildings, these themselves being part of the exhibit—typical dwelling houses illustrating the various types of architecture at different periods and in different areas.

The Domestic Arts.

The appropriate objects illustrating the daily life, the domestic arts and the industries of the people, are shown in each, and in some cases the attendants are dressed in the characteristic costumes—a feature of no little significance where different provinces have each their distinctive dress. It is a museum of this type which those who urge the establishment of a folk museum for England have in mind. It is proposed that dwelling houses typical of the English village and rural settlement at various periods should be erected in some conveniently accessible open space of suitable size. In each building it is contemplated that

appropriate and contemporary objects—furniture, domestic utensils and appliances should be set out in their natural relation to illustrate the domestic economy and daily life of the period. The houses, so far as possible, should be grouped in their natural relation as constituent parts of an English village, though arranged in such a way as to avoid incongruities in style and type. In this arrangement the rural industries will naturally have a place. In each household will be included the domestic arts, such as spinning and weaving, and in barns and outbuildings will be found a place for the dairy and for the appliances of agriculture—implements for digging and delving, as well as the plough, harrow, typical carts and means of transport, harness and so forth. Other village industries will each have its place, the village smithy, the weaver, basket-maker, potter, and the water-mill or windmill. Naturally a place will be found on the village green for the stocks, the pound and the village pond, and even perhaps for the church. Beside the evidences of the orthodox beliefs of the church a place will be found for less recognized cults, charms, and amulets, as well as the corn dolly, the garland of May Day or of the local holy well, the Grotto, or the Shrine with the Child in the Manger of the Christmas celebration. The Maypole will be a natural centre for the celebration of village dances and festivals which might be arranged for special occasions with the co-operation of folk-dance societies.

A GARDEN EXHIBIT.
Another view of the Aarhus museum, showing the inner garden court of a patrician residence.

Although it may be regarded as the function of the local museum to preserve the record of local industries and distinctively local types of exhibit, yet many of such local particularities are of sufficient importance to demand representation in a national museum. A central museum which sets out to be representative of the national culture cannot afford to neglect such specialized industries as the wood turning or the cottage-lace industries of Buckinghamshire, the iron work of Sussex, or the specialized cultures which developed in the great sheep-breeding areas such as the Cotswolds and the North.

It may be a matter of convenience that a time limit should be set to the scope of such a museum. A not inappropriate starting point might well be the end of the Roman occupation, but if space allows a series of reconstructions beginning with a lake dwelling, or even a palaeolithic rock shelter or cave dwelling, and leading through neolithic bronze and iron ages, would obviously be of the highest educative value. From that point of view the more complete the series, the greater its interest to the general public.

Such in brief and inadequate outline is a scheme upon which an open-air folk museum might be established. Since the installation of the folk-galleries in the National Museum of Wales, England alone in the British Isles has no collection exhibiting a general view of the past culture of its people. It should hardly be necessary to argue the desirability of its establishment when once the lack has been pointed out. Nor should it be necessary to meet opposition on the ground of the removal of the peasant's dwelling from its natural setting. Unfortunately, it is probable that too many buildings will be available for its use. The museum will save from destruction buildings which otherwise would disappear at the hands of the house-breaker in carrying out schemes of rural improvement. Of the objects which will be housed in the buildings, the supply is becoming regrettably smaller day by day. Yet in agricultural areas many obsolete implements have been preserved by older people who remember their use when they were young. It is perhaps not too late to appeal for the preservation of such objects in a museum rather than that they should be thrown aside as rubbish to decay when those who value them have gone.

Finally, there are two points upon which it is necessary to touch—that of a site for the museum and its cost. As regards a site, it is clear that such a museum must be centrally situated and must either be in or easily accessible from London. To set out such a museum adequately and without such overcrowding as would defeat its object, a space of fifteen to eighteen acres would be required.

A notice appeared in the *Daily Telegraph* of 12th August that Mr. Lansbury had announced the appointment of a Committee representing the Board of Education and the Office of Works to consider the question of the establishment of such a museum, and a promise of £50,000 towards the cost. The terms of this welcome announcement suggest that the land in Regent's Park now held by the Royal Botanic Society under a lease which expires in 1932 may be considered as a possible site. This was one of two alternatives recommended by the Royal Commission, of which the suitability has been strongly urged upon the Government by representatives of the Committee appointed by the Council of the Royal Anthropological Institute with the object of securing the establishment of an open-air folk museum for England.

Health in Engineering Works.

By C. S. Myers, C.B.E., F.R.S.

The subject of this article, contributed by the Director of the National Institute of Industrial Psychology, will be discussed by the British Association (Sections G and I) on 5th September.

THE problem of health in engineering works is approached by the industrial psychologist from quite a special aspect. For him health means primarily and fundamentally health of the mind, health of the nervous system. He regards a disordered nervous system as mainly and ultimately responsible for most of the bodily disorders of everyday life. Disease sets in, micro-organisms get their start when the organism on which they prey is "run down"; and nothing contributes more to this condition than nervous overstrain. The industrial psychologist therefore attends first to whatever causes undue strain or discord in mental and nervous processes. He regards worry as responsible for a multitude of bodily "sins." Even minute causes of irritation, when experienced many times daily, result in serious consequences.

One of the most common causes of needless mental strain is the worker's unsuitability for the work. His unsuitability may be due to lack of appropriate mental ability on the one hand, or to lack of appropriate temperament, on the other. There are some workers who enjoy repetitive work, others who abhor it, and some who prefer positions of responsibility while others dislike them. The remedy clearly lies in a more careful selection of employees, having regard to their mental abilities and temperamental qualities and to the requirements for success in the work on which they are to be engaged. With this object the industrial psychologist introduces not only vocational tests but also improvements in the interviewing of candidates in engineering works. By these means, as the director of one engineering firm attests, "we have definitely proved that the test gives us within an hour a measure of the (apprentice) boy's suitability, which it would take three to six months to obtain in the works under the control of a foreman."

Recent investigations, notably by Mr. Eric Farmer of the Industrial Health Research Board, make it probable that certain tests, indicative of engineering efficiency, are at the same time useful in eliminating those workers who are especially prone to accidents. Accidents are no longer regarded as "accidental." They are not equally spread over individuals throughout the community. Some workers are more prone to them than others, and are thus a menace not only to their own health but to that of their fellows. Here, again, is an aspect of the preservation of health in engineering works which appeals especially to the industrial psychologist.

In certain cases monotony may be combatted by change of work, and interest increased by the introduction of more appropriate incentives. Reduction of monotony and increase in interest cannot fail to improve the general health of the average worker. Undue strain may also arise from defective illumination and ventilation or from exposure to high temperatures. Much can be done in these directions to improve resulting health in engineering works. Their importance is generally neglected. So, too, is the study of the best posture and movements of the worker, the best arrangements of his materials, and the best designing of the machines and implements which he has to use, in relation to his physiological requirements.

The results of all these causes of needless strain are that the worker has to put undue effort into his work and to worry unduly over his working conditions. Whether owing to these causes or to resentment against often remediable industrial relations, his "nerves" get on edge, he becomes liable to waves of uncontrollable emotion, and he tends to become neurasthenic or psycho-neurotic. Under these conditions, bodily disorders develop—disorders of digestion, of circulation, etc. And thus are sown the seeds of more serious organic diseases.

Artificial Swarming of White Ants.

By R. A. J. Maguire.

In many parts of Tanganyika Territory the white ant is highly relished by the natives as a food. The author reveals the surprising fact that, throughout the dry season, swarms are produced on a large scale by artificial means, so that the natives may enjoy this delicacy when it would normally be " out of season."

We, in Africa, are so accustomed to the monotonous sequence of termite hills, scattered about any normal landscape, that the marvels taking place within these hills seldom occur to us. Sometimes, it becomes necessary to attempt the destruction of an ant-hill which interferes with the making of a road or the ploughing of a stretch of ground. The hunt for the Queen within the recesses of the vast organization which is a termitary is contested so viciously by her gallant soldiers that the permanent removal of an ant-hill is no simple matter. After hours of patient digging, the labour gang may be successful. The spoils of war are brought to the White Man. The Headman's hand is outstretched, a torpid and hideous mass of royalty lying in the upturned palm, blood starting from the countless tiny wounds inflicted in every finger by the brave defenders. The Queen is well served.

Workers and Soldiers.

Nothing found in the literature of the grotesque even remotely approaches a conception of the white ant colony. Its tortuous galleries teem with blind, patient workers, born to toil and knowing no other state. Its entrances and exits are guarded by another caste, the soldier ants. Helpless instruments of aggression, unable even to feed themselves owing to the crushing weight of the enormous, armoured mandibles which are their weapons of attack, exceeding in weight the rest of their bodies, they are perpetually under arms. Hidden in the core of this pullulating mass, guarded by her soldiers and fed by her subjects, dwells the Queen. An inert creature, her organs bedded in a mass of fat, she lays from ten to thirty million eggs in a year. Being incapable of movement, she can never leave her vaulted chamber, but eats and lays incessantly. The King ant, royal neither in aspect nor in habit, is an unprepossessing under-sized creature, who spends most of his life hiding beneath his partner's ample stomach !

In this article, it is my intention to deal briefly with one aspect of the subject of termites in general—the swarming. M. Maurice Maeterlinck, in his book " The Life of the White Ant," has said that the swarming takes place, normally, at the end of the equatorial summer ; that is to say, at the beginning of the rainy season. Those qualified to speak with authority on the subject agree with him I do not question for a moment the accuracy of this statement, so far as it relates to the normal swarming time of a white ant colony.

On the coast of Tanganyika Territory, the fertile winged males and females, later referred to merely as " fertiles," would seem to leave the termitary at the beginning of the " small," or first, rains. On many occasions I have been driven from my reading-lamp by the countless thousands of these insects, whose attraction to the light has resulted in heaps of frail wings and crawling bodies on my table, on the floor, on every square inch of space surrounding the lamp for many yards. These fertiles, similar in all respects to their industrious brethren within the termitary, save that they have been equipped with frail, smoke-coloured wings to aid them in their great quest, venture forth at the appointed time to found a new colony. The mortality among them is appalling. One male and one female, met in a suitable spot, can initiate a new termitary in a very short time, but in the world of the white ant it is seldom indeed that the time and the place and the loved one are all together.

An Awesome Sight.

The swarming is an awesome sight. I cannot do better than quote M. Maeterlinck. " . . . A spectacle is seen in comparison with which the swarming of the bees becomes insignificant. From the huge building, be it stack or pyramid or fortress, often, when there is an agglomeration of cities, from an area of hundreds of acres, there rises, as from an over-charged, bursting cauldron, pouring from every chink, every crevice, a cloud of vapour formed by millions of wings mounting to the blue, in the doubtful and nearly always frustrate search for love. Like all else that is dream and illusion, the splendid vision lasts but a moment, the cloud falls heavily to the ground, bestrewing it with wreckage ; the festival is over, love has betrayed its promise and death takes

its place." The insects, birds and animals (and the humans) who relish the succulent bodies of the fallen then flock to this "Golgotha," led by the uncanny instinct which tells them of the feast in store.

In Uganda, the swarming is eagerly awaited, for the white ant is much prized as a delicacy by the natives. The same may be said of the Tanganyika natives in general, though there are certain areas in which the white ant is held in particular esteem as a food, and others in which the eating of the termite connotes social inferiority. In some parts of the country inhabited by natives who eat the white ant a remarkable custom prevails. Throughout the dry season, swarms of white ants are produced by artificial means. The method employed in so doing is ingenious. The natives, who seem to have been acquainted with the necessary procedure from time immemorial, are thereby enabled to enjoy their favourite delicacy at all times of the year.

I shall describe the procedure, which is illustrated by photographs, but before doing so it may be well to say that it seems possible to bring about swarming at any time or season, excluding neither the height of the drought nor the period immediately following the rains, when every termitary has produced its natural swarm. Further, an artificial swarming from any given termitary does not seem materially to affect the annual natural swarming from that termitary. No diminution in the number of fertiles would seem to be apparent, although it is, of course, impossible to speak definitely when such vast hordes are involved.

Some Questions.

The observer is immediately struck by the following questions: Do *all* the fertiles participate in the natural swarming, or do a proportion of them remain in the termitary all the year round? Alternatively, does the established fact that an artificial swarming in the dry season can be followed by the natural swarming at the beginning of the rains mean that the patient, industrious colony, aware in some subtle way that it has been tricked, immediately sets to work to produce fresh legions of fertiles, to take part in the natural swarming yet to come? It is a matter which I have not succeeded in elucidating to my own satisfaction. People who have studied the ways of white ants more deeply than I have may hold definite theories on the point.

The following is the procedure adopted by the natives I have seen at work. They are the *Bazinza*, the indigenous inhabitants of the area on the south-western coast of lake Victoria Nyanza. I have seen an artificial swarming produced many times, and the performance in no case varied in essentials. The photographs were all taken on the same day, in the same place. The date was early in September, two months before the normal breaking of the rains. I have seen swarms induced in the same area in the months of June, July and August, but September has been selected in the present instance as it is, normally, the most arid month in these latitudes.

Description of Photographs.

A low, mound-like termitary was selected, and the ground above it cleared of leaves, grass and debris (Fig. 1). Branches from the surrounding bushes were then cut and stacked as shown over the termitary. The dark spots in the shade of the branches are fresh leaves, placed over the mouths of the galleries leading into the heart of the termitary in order to exclude the light. The first photograph was taken at 10 a.m. Fig. 2 shows the building of the hut in progress. The native in the foreground is arranging the leaves on the inner side. It is important that the finished structure should be free from chinks, as its object is to delude the termites into the belief that the skies are overcast and the rains are about to fall. The second photograph was taken at 11 a.m. Fig. 3, photographed at 11.15 a.m., shows the finishing touches. A quarter of an hour later the building was complete (Fig. 4). The door shown is for purposes which will be apparent later. It is thickly surrounded by leaves, so that the light within the building is dim.

At 12 noon the door was held to be too small, and after discussion it was enlarged (Fig. 5). The central figure has a calabash in his left hand, from which he is preparing to dash water over the ground beneath the shade of the leaves. The man on the right supports the water-jar. The seated individual has a short, stout stick in either hand. These sticks were cut on the spot. With them, he is preparing to beat on a third stick which has been laid on the ground near the door. Fig. 6 shows the commencement of the beating, at 12.15 p.m. The two sticks seen in motion, when beaten on the third set flat on the ground, produce a hard, drumming noise, not unlike a xylophone. At frequent intervals, water from the jar seen on the right is dashed over the termitary in the dimness under the shelter of the leaves. This water is supposed to represent rain, and the continuous vibration produced beneath by the incessant drumming of the sticks is intended to simulate thunder, or the continued fall of heavy raindrops. At 2.30 p.m. the first fertiles began to appear above the ground (Fig. 7), pushing aside the leaves placed over the exits (see Fig. 1). A shallow trench had just been dug at the door by

AFRICAN NATIVES PRODUCING SWARMS OF WHITE ANTS BY ARTIFICIAL MEANS.

Details are described on the opposite page.

the man in the picture. Into this trench the fertiles are supposed to fall A few can be seen, and there is a trail of cast-off, broken wings, leading up to the lip of the trench, left by the fertiles as they made unsteadily for the light. The stick-wielder, not seen in this picture, still continues to beat, but now a little further away and without his former intensity. He plied his sticks from 12.15 to 2.30, without pause.

The swarm is seen in progress in Fig. 8. This photograph was taken at 2.45 p.m. If it is carefully studied, fertiles can be seen almost everywhere. There is one, with wings spread, crawling up a twig in the centre of the doorway. Another, wings folded, is on the lip of the trench, which by this time is half full. Others can be seen in the foreground and within the shade of the leaves. A piece of banana-leaf has been placed on the struggling masses in the trench in order to prevent their escape. By 3.20 p.m. the swarm was over (Fig. 9). Several thousands of the captured and moribund fertiles are seen in a folded banana-leaf.

The natives pound the tender bodies into a paste. This paste is generally fried and eaten as a flavouring to grain or meat. Sometimes, it is devoured by itself. The wings are removed before pounding, as a general rule. Occasionally, the paste is eaten raw. It is highly esteemed as a delicacy among a people normally too indolent to take the trouble involved by the elaborate preparations illustrated.

Science in the Tobacco Industry.

By M. Nierenstein, D.Sc., Ph.D.

Lecturer in Bio-chemistry in the University of Bristol.

Thousands of smokers will be interested to read of the research that is constantly being made on tobacco. Many facts about this popular plant have yet to be discovered. British Association members will have the opportunity of seeing the investigations at first hand during their visit to Bristol.

It is not generally realized that the tobacco plant is grown in almost every country in the world. In many countries the locally grown and manufactured article is the one which is most largely smoked, but the introduction of the Virginia cigarette by commercial enterprise has met with great success. Although the cigarette of unmixed Virginia leaf (made, that is to say, from leaf grown in Virginia and in the adjacent states of North and South Carolina) is far and away the most popular in this country, this is not the case in the United States. The popular cigarettes there are blends of Virginia with Turkish, or with a variety known as Burley which is mainly grown in Kentucky, or with both. The attempts by Colonial and British planters to grow tobacco in Nyasaland and Rhodesia have been very successful, and some of the difficulties at first encountered have yielded to careful experimentation; the influence of such factors as latitude and climate are gradually becoming understood. A large measure of success has already been achieved in the direction of producing tobacco with a similar character and flavour to those possessed by the leaf grown in Virginia and the Carolinas, and the tobacco has, in addition, a distinctive character of its own.

While the bulk of the tobacco imported into this country comes therefore from Virginia (in the wide sense), tobacco is also brought here from many other countries, to be used for special purposes such as blending into smoking mixtures, and for the manufacture of cigars. Wherever tobacco is grown, with few exceptions, there will be found established experiment stations. These are staffed, either by Government or by business enterprise, with trained workers devoted to the problems of producing more and better tobacco, and to warfare against the many enemies of this highly prized plant. The research work which is carried out at these experiment stations is usually published, and is made use of by workers in other parts of the world.

It should also be said that a very considerable quantity of tobacco still comes from the more western states of Kentucky and Tennessee. The soil there is heavier, a different type of leaf is grown, the curing process is different from that practised in Virginia, and the resultant leaf is mainly employed in the manufacture of pipe tobaccos—Shag, Roll and Cavendish. A certain amount of tobacco of this type is also grown in Canada, and some of it finds its way to the British market.

As tobacco is not grown, except experimentally in England, we must turn to the country of origin to ascertain in what way science has been helpful to the grower. The literature of the subject is now very voluminous. The yield of tobacco in the United

States last year was estimated to be 1,501,000,000 lbs., and during the same twelve months 205,250,000 lbs. were exported to this country. The crop is therefore one of prime importance, and there is a special department for the "Study of Tobacco and Plant Nutrition" in connexion with the United States Department of Agriculture. Farmers' bulletins, dealing in a simple manner with the subjects of soils, seed-beds, fertilizers, pests and curing are obtainable free on application. Technical and research bulletins are issued at a nominal price and find their way to tobacco plantations in every part of the world. The results of special researches which have sometimes taken several years to carry out are published in various agricultural and scientific journals.

The importance of nitrogenous manures for a good yield, of potassium in the fertilizer for good burning quality, and of magnesium as well as calcium in the soil, have all been demonstrated. The finest cigarette tobacco in the United States is grown to a large extent on soil which is sedimentary in origin, and is best described as a light sandy loam, so that very much depends on the correct adjustment of fertilizer ingredients. It is inevitable that when land is cleared and devoted to the growth of a single kind of vegetation the balance of nature should be disturbed. Plant enemies and diseases, which would either pass unnoticed in the natural state of the land or be kept in subjection, attack the newcomer so carefully provided for them and flourish exceedingly. Eel-worms in the soil, fungoid diseases of root and stem, cut-worms and caterpillars, bacterial diseases spreading like wild-fire, and obscure virus diseases have all to be coped with, and are all receiving specialized attention. There is, moreover, in each State an agricultural experiment station where local problems receive special attention.

A New Research.

When the plants have been duly raised from selected and sterilized seed, transplanted from the seed beds to the fields, received their dosage of fertilizer, and are beginning to show signs of flowering, they are topped and the side shoots or suckers which then appear are removed. This is done for the purpose of retaining all the assimilated nourishment in the leaves which are left on the plant, and the farmer must then watch for the first signs of ripeness in the leaf. The leaves are gathered in, a few at a time from each plant, and hung in the curing barns. The next stage is a critical one, for unless the right conditions of ventilation, temperature and humidity are maintained day and night, the colour will not develop and fungous diseases may attack the dying leaves. What actually takes place during the development and fixing of the valued golden or orange yellow colour is not yet quite clear, but a research is at present in course of progress at the University of Bristol, which, it is hoped, will afford some definite information. The old belief that this colour was due to a special tobacco-tannin seems likely to disappear, and the theory that the colour is due to degradation products of chlorophyll may follow it. The ripe green tobacco leaf contains much starch, the cured leaf scarcely any, and the process of curing, although worked out empirically, would seem to be calculated to favour enzyme action to the fullest extent.

Fermentation Problems.

Before the tobacco is ready for export from America to this country, it is passed through long re-ordering or conditioning machines, being first dried and then brought to the required condition of moisture. Many years ago the foreman in charge of one of these machines was asked how he knew when he had the right temperature. He said he could tell by spitting on the steam-pipe and listening to the result! Many thousands of pounds of leaf had, however, been over-dried, and a very elementary application of science in the form of a few thermometers was sufficient to prevent any further recurrence of that trouble.

When the leaf is finally packed in the casks, which are about four feet long and four feet in diameter, it may remain for a time in store at an American port, or it may be brought over at once and lie in a bonded warehouse in this country for a period depending on the character of the leaf. Whilst in the cask a mild degree of fermentation takes place, amounting only to what is described as a sweating, but this reaction has a considerable influence on the sweetness and aroma of the leaf. The change is a subtle one, and does not seem to have been made the subject of research.

As tobacco is the product of such an endless variety of soils, climates, modes of cultivation and curing, it is natural to expect that when smoked, whether in the pipe or in any other form, the taste or aroma of the smoke will show equally great differences, and this is actually the case. It would be tedious to recite a list of all the countries and districts from which tobacco comes into this country, but the characteristics of each kind are so well marked that an expert can usually tell with the first two or three puffs whence the tobacco came which he is smoking.

The first serious attempt in this country to analyse

a range of tobaccos was made by Dr. James Bell, a former principal chemist at the Government Laboratory. His figures, which have been corroborated by many subsequent analyses, demonstrate the wide limits between which most of the constituents vary.

If the results of some recent analyses are quoted they will serve to show that this variation occurs even when specimens of the same grade of the same variety of leaf are subjected to chemical analysis.

ANALYSIS OF CIGARETTE TOBACCO LEAF

Inclusive of midrib, from Virginia, North Carolina and South Carolina. (Expressed on dry, sand-free basis)

Constituent.	*Percentage.*		
Nicotine	2.05	to	3 24
Ammonia...	.04	„	.14
Amides	.84	„	2.79
Albuminoids (excluding amides)	5.90	„	7.89
Nitric acid	.26	„	.58
Acetic acid (volatile acidity as)	.13	„	.36
Fixed organic acids (as oxalic)	4 41	„	6.1
Starch	.62	„	2.31
Dextrose	4 8	„	11.90
Cellulose	9.49	„	18.09
Pentosans	3.5	„	8.32
Crude fibre	8.28	„	13 45
Petrol extract, free of water-soluble matter ...	2.5	„	5.58
Ether extract after petrol extraction, free of water-soluble matter	.32	„	1.26
Alcohol extract after ether and petrol extraction, free of water-soluble matter ...	1 32	„	3.37
Cold water extract	45.94	„	48.84
Ash, free of sand and carbon dioxide ...	7.65	„	12.18

ANALYSIS OF TOBACCO ASH.

Calculated to dry basis, free of sand, carbon, and carbon dioxide.

Constituent.	*Percentage*		
Silica	1.03	to	2.85
Ferric oxide and alumina	2.82	„	9.24
Lime	25.80	„	39.97
Magnesia	3.58	„	8.99
Potash	22.29	„	33.95
Soda, by difference	.73	„	1.63
Sulphuric anhydride	3.94	„	9.31
Phosphoric anhydride	4.18	„	7.72
Chlorine	6.05	„	26.53

The influence of the various constituents of the tobacco leaf upon the "burn" of the article has been the subject of much research from the time of Schlösing onwards. A glance at the foregoing tables will show how many constituents there are in the leaf which are liable to variation. The character of the resinous constituents has undoubtedly a good deal of subtle influence upon the products of combustion, and problems such as these are being incessantly and patiently investigated.

The constituent nicotine has for a long time been of absorbing interest. Accompanied by two or three other alkaloids in small proportions, it is the characteristic feature of the tobacco plant, and has so far never been found elsewhere in nature. The physiological effects of smoking are mainly (but not entirely) due to the presence of this compound, the purpose of which in the economy of the tobacco plant is not yet definitely known, although it appears to afford an outlet for waste nitrogenous matter. It is rather curious that the proportion in which this potent body is present is not taken into account as an important factor in the actual manufacture of smoking tobaccos, but the manufacturer knows that the *strength* of a tobacco is not dependent upon the nicotine alone. The attempts to place de-nicotinized tobaccos on the market have been far from encouraging in this country.

In 1844 Mr. R. Phillips, a chemist of forty years' experience, was giving evidence before a Select Committee on the tobacco trade, and was asked whether nicotine was accessible in any distinct shape—had any quantity been collected together so as to be subjected to a chemical test? He replied that he had never seen it, nor seen anyone else who had seen it. Since that day hundreds of tons of nicotine have been produced in this country alone, to say nothing of America or the Continent, so that this article which is invaluable as an insecticide has now been placed within the reach of fruit and hop growers. New processes for its production and estimation are of almost monthly appearance, and it has been synthesized by more than one method, but so long as it can be produced from tobacco waste upon which the customs duty has been refunded it is not likely to fear competition with a synthetic compound.

Legal Requirements.

Before the introduction of cigarettes less than one per cent of the tobacco imported was returned to the customs for a refund of the duty, but the necessity arose for removing stalks, dust and sand, and at the present time something like ten per cent of the tobacco received into the factories is not utilized in manufacture. The refunding of the customs duty originally paid is contingent upon analyses of samples made at the Government Laboratory, a "Standard" for the composition of tobacco having been instituted in 1863 and revised in 1883 and again in 1904. This was necessary to ensure that Drawback of duty should not be paid on extraneous matter. The factory chemist controls the mixing of the refuse so as to ensure uniformity, and checks the analyses made by the Government chemist.

The manufacture of tobacco for home consumption is controlled by an Act of Parliament passed in 1842, to which various amendments of a limiting character have been added from time to time. For a brief and merry period after the repeal in 1840 of the Act imposing an Excise Survey, the manufacturer was prohibited from using herbs and the leaves of trees, but he made considerable use of sugar and many other ingredients, "by which evil practice the Revenue was damnified," and he was then limited to water only, with a few minor concessions in special cases. In order to make sure that the provisions of the Act were being carried out a chemical laboratory was established by the Board of Inland Revenue, ultimately becoming, together with the Customs Laboratory, the present Government Laboratory.

There is a tradition in the tobacco trade that in the old days the manufacturer tested for moisture by flinging a handful of shag against a wall. If it adhered he knew that it contained a satisfactory amount of moisture! Laboratories were not introduced into tobacco factories before 1887, in which year the amount of moisture which might be present in tobacco offered for sale was strictly limited. The moisture testing-rooms which were then installed have developed into the chemical laboratories which are now to be found in most of the large factories.

In the laboratory of the Imperial Tobacco Company* there hangs a portrait of the great French chemist, Lavoisier, for we are told in Carlyle's "French Revolution" that this eminent chemist was guillotined for putting water in the people's tobacco. The penalty in this country is not so severe, but every tobacco factory is visited once a week or oftener by officers of the Excise who are authorized to take samples before even the manufacturer has had time to test them, and if any sample, however small, is found to contain moisture in excess of the legal limit the Commissioners of Excise have the power of instituting proceedings before a Court of Summary Jurisdiction.

1,000,000 Tests.

The testing for moisture is now an essential step in the manufacture of tobacco. The dry leaf is tested upon arrival at the factory, and the amount of water which must be added to render it pliable is calculated accordingly. Uniformity of condition could not be ensured unless this control by testing were exercised to the fullest extent. Then again the tobacco leaf, owing to its high content of salts, especially potassium compounds, is extraordinarily sensitive to changes of atmospheric humidity, and this has led in recent years to much development in the matter of air-conditioning. As an instance of the care with which the manufacturer must proceed in order to ensure uniformity in his products, it may be mentioned that the Imperial Tobacco Company alone makes over a million moisture tests in the course of the year.

One of the latest applications of modern science in connexion with tobacco is reported in some work done by Goodspeed and Olson in the University of California. These experimenters have exposed the sex-cells of the tobacco plant to the action of X-rays, and from the seed so produced they have raised an extraordinary collection of varieties. Plants of a character never before seen have been raised from what has been regarded as a stable type, and it now remains to be seen whether those variations which appear to be valuable can be fixed and made self-reproductive.

* The writer is indebted to members of the Company's scientific staff for assistance in compiling this article.

British University To-day.

(Continued from page 300.)

Among the university societies one which is out of the common is the Spelaeological Society, founded about 1919 to explore the caves of the Mendips. In Aveline's Hole the Society found broad-headed skulls mixed with long-headed ones in clearly late Palaeolithic times, the earliest known form of broad-headedness in England. By invitation of the Royal Irish Academy the Society has explored a cave at Kilgreany. For the first time the presence of man in late Pleistocene times has been proved, and a species of vole—a field-vole, *microtus arvalis*—new to Ireland has been discovered.

The Union buildings are the home of the University Appointments Board as well as of undergraduate societies. The secretary of the Board, being also secretary of the Union, is brought into close touch during their undergraduate years with those who may on graduation apply for his advice and assistance, and has thus every opportunity of estimating their abilities and their suitability for vacancies which may occur. It is interesting to notice that an increasing number of graduates find, and indeed seek, employment in the Dominions and Colonies and in foreign countries. For some years after the war parents, naturally enough, were inclined to discourage their sons and daughters from going abroad. That period has now past, and our young graduates are off to Canada and South Africa, to Mexico and Singapore and the Sudan, the women no less keen than the men to see the world. This is one of the healthiest signs of the times; the spirit of the old Merchant Venturers is still alive in Bristol.

Book Reviews.

Crucibles: the Lives and Achievements of the Great Chemists. By BERNARD JAFFE (New York: Simon and Schuster. $5.00.).

This is a very noteworthy book. It appears as "the winner of the ($7,500) Francis Bacon award for the humanizing of knowledge sponsored by the Forum Magazine and Simon and Schuster" among some hundreds of competitors It is described by the late Dr. Slosson, who was one of the judges, as "the history of chemistry, told in biographies, brilliantly written, full of interesting personalities, and with the necessary scientific explanation deftly worked in with as few repellent terms as possible." Dr. Slosson, whose regretted death has deprived America of a real pioneer in the popularization of science, the founder of its "science news service," was highly esteemed by all those in England who knew him and his work He was not at heart a sensationalist, he had a deep and fervent love for science and a belief in the greatness of its mission, but at the same time he understood very clearly the limitations of the public to whom he addressed himself, and he gave sanction to a style which, while doubtless suitable in America, has peculiarities that make it not altogether acceptable to the British public English men of science are perhaps apt to be rather merciless towards this brand of popular science, so different from the traditions of Tyndall and Ray Lankester of the past, and unlike, for example, the Bragg and Arthur Thomson of to-day.

This allusion to Dr. Slosson is made not merely to give weight to his opinion, and to pay incidentally a tribute to his services, but to prepare the reader of Mr. Jaffe's book for an element of its style, which has to be accepted much as one accepts a foreign idiom. That being done, it will be recognized at once that this is really a serious piece of scientific authorship, carried through after long preparation and great labour, by an extraordinarily well equipped and talented writer. The bibliography of "Sources," that is appended, shows the wide range of scientific literature which has been assimilated and very skilfully drawn upon by the author, to make something like a connected narrative of chemical discovery. Each chapter is headed with a name, and a beginning is made by depicting the state of the chemical or alchemical mind and doings just before the time of Paracelsus For this purpose the author has chosen to give a summary of the life of Bernard Trevisan (1406-1490), as recorded in the Nurnberg work published by Casper Horn in 1749, containing the writings and autobiography of Trevisan The picture is lively and entertaining and serves its purpose, but it seems a little eccentric to put as the first figure, in sequence with fifteen great personalities, who have all given a notable turn to real scientific history, one whose very name, to say nothing of his performances, is hardly known to chemists, and counts for nothing, or next to nothing at all, in chemical history.

Following upon Trevisan, we have standing at the head of chapters the names of Priestley, Cavendish, Lavoisier, Dalton, Berzelius, Avagadro, Wöhler, Mendeleeff, Arrhenius, Madame Curie, J J. Thomson, Moseley, Langmuir. This selection may seem in some respects arbitrary, but it very well suits the author's plan of exposition and it will be found that, with few exceptions, substantial justice has been done to other discoverers whose names might on another scheme have taken their place at the head of chapters. The most noteworthy instance to excite regret is probably that of Boyle. It seems hardly fair that anyone proceeding to learn something of the history of chemistry should not have impressed on him clearly the profound influence exerted by the work and writings of the man whose time-honoured title, "the Father of Scientific Chemistry," surely remains undisputed

As already indicated, Mr Jaffe's book is an exposition of chemical discovery interwoven with biography, tracing the history of chemical discovery and chemical philosophy from the beginning of the phlogistic period to the present day. Historical sequence is not always strictly followed, but where it is departed from there usually seems to be justification Indeed, in this connexion the author shows a good deal of ingenuity.

It is inevitable that in executing so large a task there should be some mistakes In the history of chemistry before the eighteenth century, and in the very latest period which has brought the science into the meshes of wave mechanics, the present reviewer has no pretensions to expert knowledge. There may, for all he knows, be statements in these regions that will bring down the hand of correction, but over that range of chemical history with which he is tolerably familiar the book gives no serious ground for complaint. Some errors and disputable statements have been observed, but they are of no great importance and need not be recorded in this notice

As an attempt at popularization the book has great merit, though in places the exposition seems to suffer by the ejaculatory and sometimes almost rapturous style. This is most noticeable towards the end, where the laudatory terms applied to the living make one feel for their sakes a little uncomfortable It is very difficult for a chemist to foretell how far a perusal of the book will give an understanding of basic chemical ideas to those who have never worked in a laboratory. Though there is no explicit statement on the subject, the readers in view are presumably "the intelligent public," which must be taken to mean intelligent people who have had no training in the practice of science. The difficulty of dealing with such readers has been recently discussed elsewhere by the present reviewer, and reference was made in the editorial column of this journal to his insistence on the difference of "knowing" science and "knowing about" it. Whether or not the book may succeed beyond its forerunners with general readers, it will be well worth reading by students of chemistry at an early stage of their studies. In spite of the element of style already referred to, there is a real feeling throughout for the glory of scientific conquests and for disinterested and self-sacrificing effort in what is called sedately by the Royal Society "the improvement of natural knowledge."

ARTHUR SMITHELLS.

The Use of the Microscope By JOHN BELLING (McGraw-Hill. 20s).

This is described as a hand-book for routine and research work The author holds the position of cytologist at the Carnegie Institution of Washington, and is able to write from many years of experience in the practical use of the microscope. Mr. Belling seems to have made a particularly close study of the numerous adjustments and variations of method which play so important a part in the perfection of the image in the microscope. These methods are discussed and criticized at some length. The book contains twenty-seven chapters, the first sixteen of which are devoted to a detailed description of the instrument and its parts. The author then describes methods of testing, rules for high-power and routine microscopy,

a hundred microscopical objects of biological interest, and other important aspects of the subject

In an interesting chapter the author outlines two important discoveries made with the microscope. Both were made with the achromatic type of instrument, and Mr. Belling suggests that they may be placed " among the few greatest discoveries." The first was the cell theory of living organisms. " Every cell from a cell " was, and still is, the foundation of ontogeny and phylogeny. This discovery was made from microscopical observations of plants and from a study of animal tissues. The important deductions are that each plant and animal normally comes from a single cell ; that all the different tissues are usually formed by permanent changes occurring in certain of the cell progeny of the original cell ; and that the faculty of reproduction (and the partial reproduction called " regeneration ") shows, in the tissues of plants and animals, all grades, from complete reproduction by any cell, to the absence of any cell division at all. These more or less permanent changes in the cells, as they multiply to build up the tissues, are almost without any explanation to-day, and remain a challenge to investigators.

The second great microscopical discovery, the author thinks, was the chromosome theory of inheritance.

Mr. Belling predicts that further progress with the microscope will come from a triple combination. The quickest method of fixing must be combined with the sharpest staining process, and also with the most correct microscopy Colours of stains, he points out, should be adapted to the yellow-green (or other) screens in use Photographs taken with the microscope will doubtless be sharp, if the laws of optics are obeyed as well as they are in the taking of motion-picture photographs Such sharp photographs should lead to valuable discoveries.

This book will, perhaps, appeal most to students of microscopy, whom the author has obviously borne most in mind. The questions at the end of the book cover almost every aspect of the subject, and the practical exercises are also a valuable addition.

Captain James Cook, R.N. : A Hundred and Fifty Years After. By Sir Joseph Carruthers, K C.M.G., LL.D. (John Murray. 7*s* 6*d*).

In this indignant little book the author deplores the lack of veneration among " our young people nowadays " for the memory of the founder of Australia. " To permit the memory of Captain Cook to remain under a cloud," he writes, " is to contribute towards a slackness in that spirit of veneration which is an essential of the higher character of our race " It is surprising to know, in the first place, that the founder of Australia has ceased to be venerated and, secondly, that his memory is under a cloud With almost fanatical reverence, Sir Joseph refutes " the untruths and misconceptions which have proved harmful and unjust to the reputation of the great explorer," and produces testimony from native Hawaiian sources as well as from authentic records of English eye-witnesses

It seems doubtful, however, whether the book will prove successful in inspiring the spirit of veneration. It contains little of scientific interest that is not already known, the literary style is tedious, and there is a strong suspicion of bias Sir Joseph devotes considerable space to an analysis of early criticisms of the explorer, launched by a variety of writers. A little more modesty might, perhaps, have been looked for in the author's preface, in which he sets out at length his own part in effecting a more adequate public recognition of the qualities of Captain Cook.

Interviewing Wild Animals. By F. Ratcliffe Holmes. (Stanley Martin & Co. 3*s*. 6*d*.).

The author of this book is one of the new and more attractive type of sportsman who prefers to shoot his game with the camera rather than the gun. He tells us here how his films were obtained, and the seemingly unsurmountable difficulties which he overcame in obtaining them, though he does not conceal the fact that these difficulties sometimes overcame him. As Colonel H. Marshall Hole points out in a Foreword, the wild life of Africa, which has suffered so greatly in the past from indiscriminate and unnecessary slaughter, has found a new ally in the cinematograph There is more interest and instruction in one living picture of animals in their natural haunts than in a hundred trophies.

It is difficult to do justice in a short review to a book so thronged with incident and observation Its dangers and thrills include encounters with lion, rhinoceros, leopard, elephant and buffalo Of these animals Mr. Holmes considers the buffalo the most dangerous, for it is " inspired by a downright hate of humanity."

One of the most interesting chapters is entitled " The Way of the Wild." The author concludes that the popular estimate of the comparative values and uses of animals' senses of sight, hearing and smell is erroneous His observations have proved to him that " the sense of smell alone conveys definite and detailed knowledge " Animals did not associate the noise of the cine-camera with human beings, and (unlike some British birds) failed to see the lens. Their eyesight, he says, can register *movement*, even at a great distance, but for analytical purposes, such as looking into bushes concealing the camera and its attendants, it is greatly inferior to ours

Mr. Holmes also thinks that wild animals possess a telepathic sense which warns them of danger . it is latent in us all, but exists in them in a more highly developed form. In another chapter, " Can Animals Talk ? " he develops this theory further, and relates some very curious experiences which suggest that wild animals possess something which is at least equivalent to the power of speech, by which they can convey definite information to each other.

There are some rather pungent comments upon scientists who would make protective colouration in nature explain too much. " The real question," he says, " is not whether animals so quaintly or curiously marked as the zebra, giraffe, and leopard are more difficult to see against a back-ground which *happens* to be similar to their own colour scheme, but whether they are camouflaged amidst the surroundings in which they are most commonly to be found." He concludes that they are not, and gives his reasons. He admits that nature has afforded special protection to *e.g.*, caddis worms, by imitative colouration, but points out that they are only to be found amidst surroundings which assist the camouflage. This seems to be much the same conclusion as that which Mr. Pycraft adopts in " Camouflage in Nature," when he says " protective colouration would not be of the slightest service unless ancillary to behaviour which must adjust itself to the colouration."

Besides animal lore, the book contains much fascinating information about native customs and superstitions. Mr. Holmes relates one instance of native magic which is almost uncanny : he killed two wildebeestes for food, but the carcasses were a considerable distance apart, and he had not enough porters to guard them both from the vultures. His gunbearer tied certain knots in the hair of one animal, assuring him that this was a charm which would keep the vultures off. Two hours

later the wildebeeste was found intact; though the vultures were wheeling about it, none had touched it.

It is a pity that the book has no index. But it is one to read and keep.

E. W HENDY.

Points of View. A Series of Broadcast Addresses (Allen & Unwin 4s 6d)

The addresses reproduced in this book are described as "a small instalment of an experiment in popular education," and were broadcast from London last autumn by Mr. H G. Wells, Sir Oliver Lodge, Dean Inge, Professor J. B. S. Haldane, Sir Walford Davies, and Mr. G. Lowes Dickinson, who also contributes an introduction and a concluding summary. "Such addresses as these," writes Mr Dickinson, "will not, of course, supersede schools and colleges, still less books; but they may reach a larger and more miscellaneous audience. They are seeds thrown out over the world at large, and their crop will help to determine its future. Public opinion is now in the making, not only in the West, but in the East, and this is one of the ways in which the important question is being put and answered: Can democracy succeed?"

Mr. Dickinson, who opens the series, commences by defining democracy · "I am a democrat; by which I mean that I believe in free and open discussion about all laws that exist, or ought to exist, and in the right of anybody and everybody to advocate their change, not by force but by persuasion."

Mr. Haldane's point of view is the most comprehensive of any of the contributors. He discusses in turn orthodox religion, education, censorship and the suppression of free thought, health and the comparative healthiness of various occupations, the birth rate, the death rate and the psychological value of marriage, and concludes with an appeal for wider educational opportunities for the children of skilled artizans. Mr. Haldane's is the point of view of the young man, and it is interesting to compare it with the views of the other contributors, the youngest of whom is twenty-seven years Mr Haldane's senior. In criticizing the present educational system, he suggests that it is unjust to children because the majority do not get a fair chance: practically none are taught the truths of science from a human point of view "Science teaching should begin, not with a mythical body in rest or in uniform motion, but with the human body."

Sir Oliver Lodge stresses the need for living together peaceably by common consent, and cites as an example police regulation of traffic. He makes a spirited attack upon the "old abominable motto," that if we want peace we must prepare for war, and points out the impossibility of private life under such conditions Sir Oliver forecasts the establishment of an international parliament, "when the whole human family will govern itself by mutual agreement."

Guide to the Orchids of New South Wales. By H. M. R. RUPP, B A. (Angus and Robertson. 7s. 6d.).

The few standard works on the Australian orchid are not readily accessible to a great number of nature lovers on account of expense, and consequently there must be many who have been deterred from studying these plants because they have been unable to find helpful books at a popular price. The author outlines the salient features of the plants and supplies a number of excellent illustrations. "The book makes no claim to be a technical handbook," which is a decided point in its favour, and the author has studiously avoided technical terms Where he has been compelled to use scientific names, they are fully explained in a glossary. Many details have been omitted which would be considered essential in a handbook of technical descriptions because, as the author explains, to a non-botanist they are merely tiresome and confusing

In a preface the author makes some preliminary remarks concerning the general character of the orchid which will be welcome to those whose knowledge of the flower is rudimentary. It is generally accepted that the orchid is the most highly specialized member of the kingdom of flowering plants, and an outstanding feature of its character is that, in the course of its evolution, it has developed beyond the stage of stamens and style. On the side of the column which faces the front of the flower is a sticky swelling or disk, often difficult to see but easily detected by touch, called the stigmatic plate Above this is an oddly-shaped receptacle containing one or more little sacs of extremely fragile texture—the anthers. At a touch they break, exposing the pollen, which in most orchids is viscid, not powdery. This is the main feature which distinguishes the orchid from other flowers.

The amazing devices contrived by orchids for making this revolutionary development effective constitute a fascinating field for study, beyond our present limits. From the point of view of their habits, orchids are known technically as Epiphytes, Saprophytes and Terrestials. New South Wales has over two hundred species of orchid known to science, of which forty-three are epiphytes The home of these flowers *par excellence* is the strip of country from the Dividing Range to the coast, most of the epiphytes being restricted to this area. Terrestials occur plentifully from the coast across the Divide to the western slopes, and extend in rapidly decreasing numbers to the western plains. Epiphytes, saprophytes and terrestials are described in detail in the succeeding chapters and many interesting illustrations are given.

Nature Rambles. Vols III and IV. By EDWARD STEP, F.L S (Frederick Warne. 2s 6d each.)

Readers of the first two volumes in Mr. Step's interesting series will welcome the publication of Volumes III and IV, which now complete the "Come with Me" books. The series is described as an introduction to country lore, and comprises accounts of rambles in rural places in spring, summer, autumn and winter. The aim of the author is to awaken an interest in the common forms of animal and plant life, and the simple descriptions of various aspects of natural life serves as a valuable introduction to more serious study. Numerous familiar plants, insects and larger animals are discussed, but space is also devoted to a number of lesser known subjects, and illustrations have been included on a liberal scale.

While we imagine that the books are primarily intended for children, they are by no means childish, and there is no doubt that they will prove interesting and instructive to those who wish to extend their knowledge of plant and animal life and have not the leisure at their disposal in which to study the more advanced works. In Volume III the author describes summer in the pastures, along the seashore, beside the stream, on the downs and among the chalk hills. The concluding volume contains descriptions of the common in early autumn, autumn in the oakwood, in beachwood and chalk hills and among the pine trees

DISCOVERY

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Editorial Notes.

THE publication of our September issue coincided with the news that the remains of Andrée, the Norwegian explorer, had been discovered in the Arctic ice, thirty-three years after his fatal balloon expedition. The body was found on Kvito Island by a Norwegian party while exploring Franz Josef Land this summer, and was identified by initials on the clothing. The remains of his companions, Strindberg and Frankel, were also discovered in what was evidently their last camp. Most important of all, the finds included Andrée's diary and log book, the diaries of Strindberg and Frankel, and a roll of films. Extracts from Strindberg's notebook have already been published. The contents of Andrée's diary also throw light on the fate of the explorers, hitherto a complete mystery. From the preliminary reports printed in *The Times* by Dr. Gunnar Horn, it appeared that Andrée may have lived for at least two months after the wreck of his balloon. In view of later investigation, it is thought that the explorers may have survived for a much longer period, although the actual duration is not known. Andrée and his companions were, apparently, carried on ice-floes to the scene of their death before being overcome by cold and exhaustion. To readers of *Discovery* the conjecture that the explorers survived for so long is of special interest, for the possibility of "living off the country" in the Arctic was supported in our columns by no less an authority than Sir Hubert Wilkins. The question has, of course, been long disputed by explorers, the majority maintaining that to live by hunting is not usually practicable in the Arctic regions. The stoutest advocate of the opposite view is Vilhjalmur Stefansson, who claimed to have lived by this means for a period of six weeks after his provisions had become exhausted. Among the attacks which unfortunately characterized Amundsen's biography, none was more scathing than the scorn poured upon this achievement, Stefansson being bluntly accused of fabrication. It was then that Sir Hubert Wilkins wrote to *Discovery* (January, 1928) in defence of his fellow-explorer, confirming the view that the pack-ice is by no means so hostile to human existence as is generally supposed.

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Polar exploration lends itself to controversy more than any other science. This must necessarily be the case as so often the exact results of exploration perish with their authors. Andrée's diary may help to solve the pack-ice question. But whatever it finally reveals, everyone will rejoice that this Norwegian pioneer was found by fellow-countrymen while engaged many years later in the same task of exploration. The simple but impressive reception which met the party at Tromsö was a fitting end to Andrée's career. The writer of these notes can well picture the scene, as he happened to visit this northern fishing town in 1928 when the search for Amundsen was in progress. The Italian seaplane which joined in the search had just stopped in the harbour on its northward journey, and the same feelings of sympathy and comradeship were reflected in the faces of all the inhabitants, most of them fishermen engaged themselves in whaling and in the polar seal trade.

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Following the discovery of the Andrée remains is the news that relics have been found of the camps of Sir John Franklin, the explorer, whose expedition to the Arctic perished in 1847. The discovery has been made by Major L. T. Burwash, the Canadian

Government geological explorer, who has just returned to Edmonton, Alberta, after making the first airplane flight to the district of the North Magnetic Pole. Franklin had set out to find the north-west passage, and was last heard of in Baffin Bay in the spring of 1845. Thirty-nine expeditions were made in the ten years following his disappearance in the hope of finding traces, but it was not until fourteen years later that a record of the expedition was found at Point Victory which clearly showed that Franklin had died in 1847, after the object of his expedition had been achieved. In 1860 another search was made which proved fruitless, but sixty-six years later a skull and some remains of sailor's uniform were found. The contents of the documents now discovered have not yet been revealed by Major Burwash, who is retaining them for the purpose of making an official report to the Canadian Government. Among the relics are a sailor's jacket of the style worn in the early part of last century, a pair of bearskin trousers and a portion of a tent.

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The failure of Professor Peccard's first attempt to ascend to a height of fifty-two thousand feet in a balloon, which is fitted as a physical laboratory, has not discouraged this enterprising Swiss scientist from contemplating a second attempt. Unsuitable weather made the ascent impossible, and Dr. Peccard and his assistant are now awaiting more favourable conditions. The professor's aim is the study of the conditions of the upper atmosphere, and the balloon, which is constructed of aluminium and is ninety-eight feet in diameter, is hermetically sealed and has been designed to resist enormous atmospheric pressure. Half of the aluminium ball is painted black, and if the internal atmosphere becomes too cold, the painted half may be turned to the sun so that it may absorb the heat more readily. If, on the other hand, the temperature becomes over-heated, the aluminium surface will be turned to the sun. Whether Dr. Peccard's experiment will meet with success has yet to be shown; the last attempt to ascend to an altitude of more than 45,500 feet ended in disaster some years ago for an American scientist. At any rate, the professor will be wished the success which his laborious preparations deserve, and the result of his second attempt will be awaited with interest.

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This month the Royal Geographical Society celebrates its centenary, and on 21st October the Duke of York, on behalf of the King, will officially open the Society's new buildings, which include an imposing hall and library. Delegates from many of the leading geographical societies of the world are to attend the celebrations, and an important feature will be a reception on the following day in the Society's building at Kensington Gore, when the overseas geographers will be entertained by the President, Council and Fellows of the Society. A series of addresses dealing with the Society's history are to be given at the centenary meeting in the new hall on the evening of 21st October. It is announced that the Prince of Wales has accepted an invitation to preside at the centenary dinner which will be held at the Connaught Rooms on the evening of 23rd October. Incidents in the history of exploration and the subject of the Hospitable Globe will form topics of discussion at meetings on 22nd and 23rd October in which members of the Society and overseas guests will take part.

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The digging of a gravel pit at Brown Candover, a village near Winchester, has revealed what is thought to be a Bronze Age urn field. Three burial urns, each containing human remains, have been discovered and are being sent to the British Museum for reconstruction and acceptance. These interesting discoveries are described in a letter to *The Times* from Mr. S. E. Winbolt to whom the urns have been entrusted. Cremation and urn-deposit, he writes, are characteristic of the Bronze Age in this country, but mound burials are more common than cemetery burials. The first urn, recovered in many fragments, but largely reconstructed, is of poor clay, imperfectly baked, red outside and black inside. The cordon is vertically incised at intervals with a stick or bone.

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Sir Arthur Keith, who examined the remains, thinks that they are the remains of a young adult, the bones of the skull being still unjoined—a woman rather than a man. The second find is a food vessel used as an urn. The collar above the cordon is ornamented with transverse discrete lines composed of long scratches, first right, then left, with vertical lines. The material of this pot, hand-made like the others, is coarse clay mixed with particles of chalk, and burnt bright red nearly through. The third is a big urn, the considerable contents of which have not yet been examined. The ornament above the cordon and below an encircling line under the rim is of chevrons incised in a jagged manner, probably with the broken end of a bone. About half the pot held together round the contents and the rest was in forty to fifty fragments. No ornaments were found in any of these urns, but there were pieces of charcoal and burnt flint. It is not known in what position, upright, inverted, or on the side, they were buried.

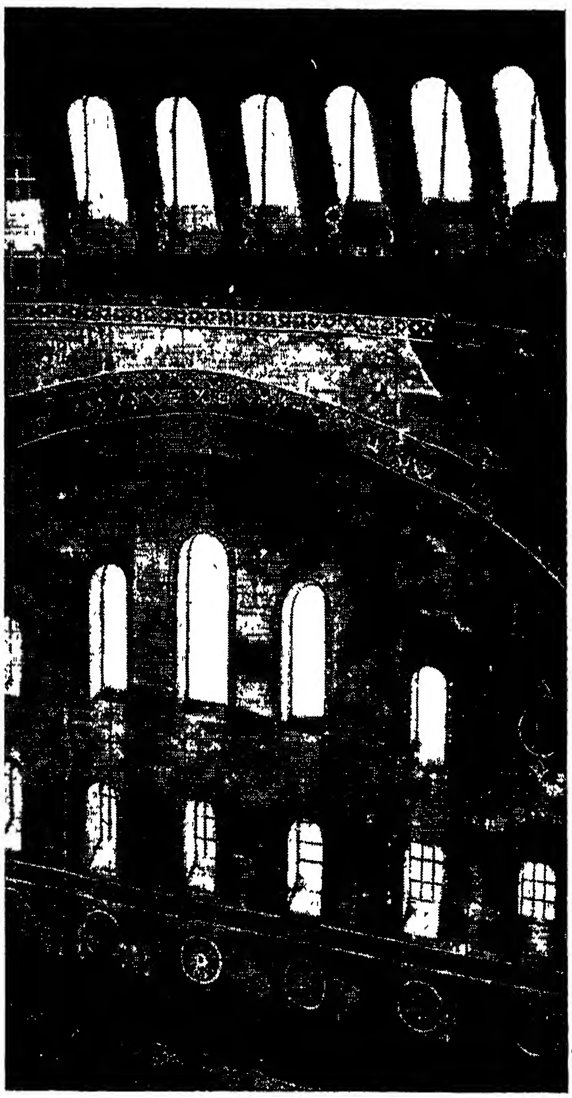
Saint Sophia Revisited.

By Stanley Casson, M.A.

A remarkable feature of the Church of Saint Sophia is that hardly an archway is symmetrical and hardly a line is straight. Mr. Casson recently examined the building and discussed the matter at length with the architect in charge of repairs. He here reveals for the first time the cause of the distortions.

St. Sophia is remarkable in so many ways that one tends to forget some of the most noteworthy while one is, for the moment, overwhelmed by its more obvious marvels. That it took but five years to build, yet cost the enormous sum of sixty-four million pounds sterling, is a record which stands alone in the religious building of the world, but it always seems to me more remarkable that the building should have survived the catastrophes in which the parts of the city that surround it have been continuously involved. It had hardly been built when it was subjected to a series of severe earthquakes which lasted, on and off, for twenty years; perhaps the most continuous and recurrent series of earth-tremors that the city has ever undergone. Exactly twenty years after its dedication the church suffered the only disaster that it ever sustained; the dome fell in and much of the fabric was damaged. The earthquakes had had their inevitable result.

But what is, I think, one of the most remarkable features of this building, is that it has never suffered any perceptible damage between this collapse of A.D. 557 and to-day. Fire after fire has raged below the great church; siege after siege has echoed round its walls, and conquerors have twice swarmed into its precincts and brought murder and massacre into its holiest parts; even as late as 1755 a devastating fire brought the lead dripping molten from its domes and roof, and from 1915 to 1918 aeroplanes dealt destruction within the city walls; yet the great bastion-like church stands to-day firmer even than when it was built, for the very catastrophe which brought its dome crashing to the ground in 557 was destined to strengthen its fabric and solidify its structure.



THE DOME OF SAINT SOPHIA.
This photograph, taken from the gallery, clearly shows the distorted arches.

On a recent visit I talked at length with the able Turkish architect to whom was entrusted the repair of the dome after the dilapidations caused by ten years of neglect during time of war. He knows the fabric of the building inch by inch, and with him I examined every crevice of its highest dome, within and without, and looked at every portion of the gallery that runs giddily round the dome and every slope and slant of the mighty leaden roof. In the course of this examination he pointed out to me the fact that there is hardly an archway that is symmetrical and hardly a line that is straight. At first I thought of the refinements of the Parthenon, and wondered if the Byzantines had such deep consideration for optical effect. But the distortions were too marked, the lines too broken. Every arch was warped, every wall sloped, but without seriously affecting the grand effect of the whole.

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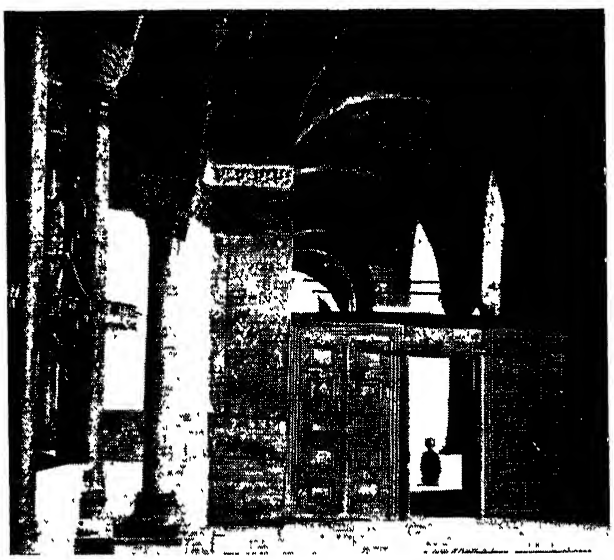
Both on the dome and on the rest of the roof the lead roofing has been completely renewed so that no moisture can now penetrate the building from above, and the danger to the mosaics of the dome, apparent in recent years, is thus avoided.

For the rest, the fabric seems to need neither renewal nor restrengthening, since none of the existing cracks have shown any tendency to increase and, as I have explained, the building is far more solid than was ever imagined. For future improvements there is much room, even on the assumption that the building always remains a mosque. By a simple process of ordinary cleaning, the marble revetments of the interior walls can be made to show their colour and their superb variety. The floor can be cleared of the carpet whose alignment towards Mecca so unhappily disturbs the normal orientation of the main building

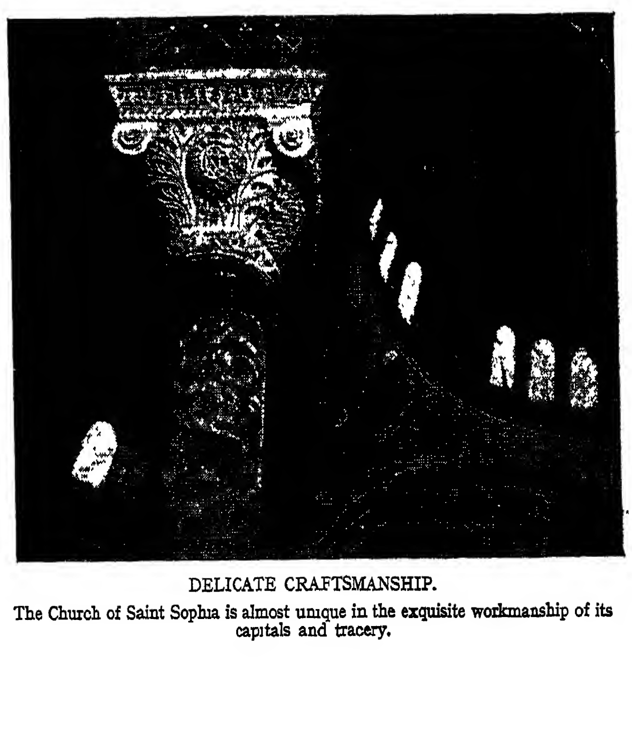


A DOORWAY OF MARBLE
Among the improvements which the author suggests should be carried out is the cleaning of the marble.

to the east and its internal arrangements. The great bronze door at the south entrance, the only original door surviving from the time of Justinian, with its austere decoration and its perfectly preserved monogram devices, could be cleaned with immense advantage.

Of the mosaics little can be said. It is hardly to be hoped that even under the enlightened regime of Republican Turkey they will be relieved of the white-wash that encumbers them, for St. Sophia is a storm centre of religious faction and political intrigue and a building far harder to touch than any mosque in Stamboul. From the close examination which I have made of the mosaics of the dome and of the upper galleries, I doubt if a complete cleaning will result in much except grave disappointment. The mosaics have been irreparably damaged by the passage of time and the intrusion of moisture in the period that has intervened between the conquest of 1453 and the repairs of Fossati. Much that looks like obscured mosaic design from a distance is in reality but painted plaster that hides a patch from which the mosaic has fallen. The best preserved and the most impressive mosaics are the four Cherubim whose heads are obscured by gilt wooden stars affixed by faithful Moslems who could not tolerate the representation of the human face. These can be made perfect and will remain, perhaps, as the finest mosaics of the church.

Another and most profitable alteration would result from the lifting of the Turkish flagstones of the floor of the gallery and of the main floor. Beneath will certainly be found the burials of Christian priests and dignitaries and of Crusading notables. In many of the smaller churches which were converted at the Conquest into mosques the Christian tombs were ruthlessly violated and robbed of their contents. That this was also the case in St. Sophia is less likely so that the probability of discoveries in tombs is considerable. The actual tomb, believed inviolate, of Henry Dandolo himself still lies visible, with his name in Gothic characters, in a corner of the upper gallery. What treasures these tombs might contain is incalculable. But nothing can dim, even in its present condition, the splendour of this oldest cathedral of Christianity. The amazing vastness of the space which is enclosed by walls unsupported by pillars, the soft dark colours and the exquisite variety of capital and tracery, make it a monument which has never been exceeded either in architectural daring or in perfection of detail.



DELICATE CRAFTSMANSHIP.
The Church of Saint Sophia is almost unique in the exquisite workmanship of its capitals and tracery.

The Village Heroes of Kathiawar.

By James Hornell, F.L.S., F.R.A.I.

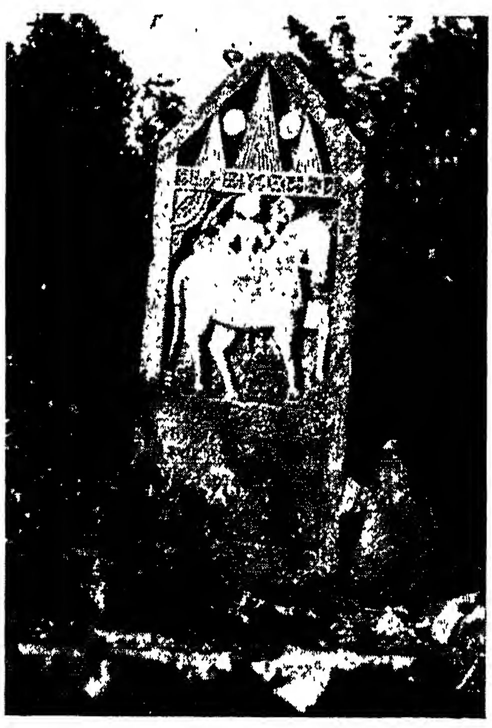
Late Director of Fisheries to the Government of Madras.

An interesting link with mediaeval times is to be found in the Peninsula of Kathiawar, where Feudalism is still the form of government. Hero worship is an important national trait, and in every village, however poor, throughout the land there are elaborately carved monuments, erected to the memory of local warriors.

KATHIAWAR, the great *presqu'île* midway between Bombay and Karachi on the north-west coast of India, is changing rapidly owing to the invasion of the railway and the building of modern commercial harbours at Port Okha and Beti Bandar, to say nothing of the advent of the schoolmaster and the political agitator. But it still remains a feudal land, a country parcelled out among some hundred and fifty chieftains, each claiming sovereign rights within his territory. Some have real power and importance, among them the enlightened Gaekwar of Baroda and the once popular cricket idol, Ranjit Sinhji, now the Maharaja Jam Saheb of Nawanagar. The latter is a progressive and enterprising ruler, whose capital of Jamnagar, remodelled and rebuilt with the assistance of Sir Edwin Lutyens and others, is probably the most attractive of modernized Indian capitals. Many of the other rajas, nawabs and princelings own but a ruined fortalice, perched on a hillock, the iron-spiked gates still shut and barred at sunset, and surrounded by clusters of mean houses, huddled under the walls for protection against raiders.

The land is an epitome of England and Scotland in mediaeval times; to travel through the country from village to village, mounted on one of the spirited little ponies for which Kathiawar is famous, escorted, perhaps, by a fierce-looking bearded ancient armed with dagger and scimitar; or to crawl at funereal pace, jolting and swaying over deeply rutted roads in a creaking bullock cart; such experiences give a far clearer insight into life in the middle ages than the study of all the books ever written on the subject. "What is that pall of smoke away to the north?" I once asked a village headman on the border of the Gir forest. "That," he replied, "is where a band of outlaws have their home. They have become too troublesome and bold of late, and so the Nawab has ordered them to be burned out."

These outlaws are gentlemen of the Robin Hood variety. They have their own code of honour. When they plan a raid on a village, notice is usually sent to the headman, informing him of the decision to descend upon his village and remove whatever they may consider of service to themselves. No hint is given of the date when the raid is to be carried out. It may be within a few days, or months may elapse before it occurs. And, like Robin Hood, these modern outlaws have a retributive way of despoiling most thoroughly whoever is an oppressor of his neighbours. A greedy moneylender suffers in particular. The raiders love to rifle his money bags and to destroy the records of debts owing to him. Because of this the outlaws are popular with the poorer villagers, and such sympathy is the greatest asset the outlaws have; it secures them early information of any move to be made against them; if captured, an ironclad alibi prevents justice being done.

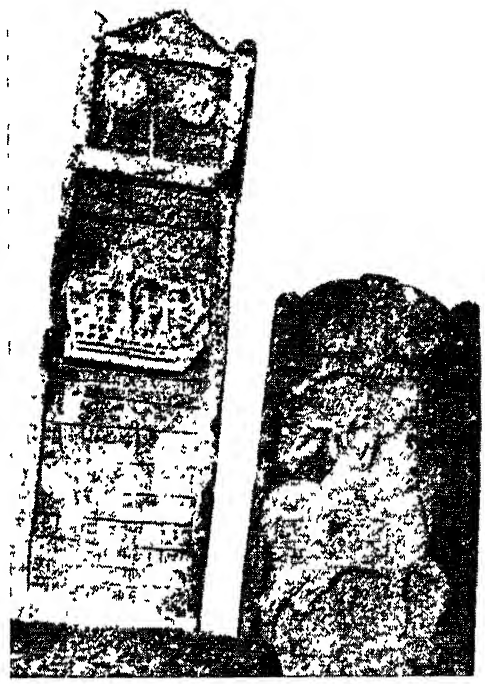


A TYPICAL MEMORIAL

The rank of the hero is shown conventionally by the trappings of the horse he rides, if they are richly caparisoned, the man was a chieftain, while inferior ranks bestride a plain saddle

Their numbers are recruited to a considerable extent from the families of the smaller chieftains. In India, if a man possesses money or position, his poor relations consider it to be his bounden duty to provide for them. The thread-bare courts of the Kathiawar princelings are crowded with

these people. From time to time an impecunious chief, finding the drain at last unbearable, rises in wrath and drives the idlers out. Knowing no trade, for they are too proud of birth to learn one, how may poor gentlemen live unless they frequently join an outlaw band? Recruits of this type are welcome. Desperate, landless men, bitterly resenting the treatment received from the head of their clan, and with friends in his stronghold, their help and knowledge are invaluable should the outlaw captain ever decide to raid the chief's possessions.



A PIRATE'S CENOTAPH.

By far the most interesting of these quaint memorials bears the representation of a square-rigged, four-masted ship of the East Indiaman type. It commemorates the death of a pirate

Many of the people of Kathiawar, in addition to those of the ruling caste, claim to be of Rajput origin or, at least, of Rajput affinity. Their customs are similar and bravery is still esteemed the highest virtue. Wherever villages contain a strong element of the Rajput type, memorial stones to heroes and heroines long since dead are usually to be met with. These are particularly numerous in the little territory of Okhamandal, belonging to Baroda, at the extreme north-western corner of the peninsula. Here is the home of the Vaghers, a once lawless and turbulent tribe. From time immemorial they have avoided honest work, represented here by strenuous agricultural labour in a land of deficient rainfall; rather they preferred a gentleman's life of piracy and pillage. Piracy was greatly circumscribed early in the nineteenth century owing to the vigilance of British ships of war, but predatory raids by land continued unabated till 1859. In this year their overlord, the Gaekwar of Baroda, found himself unable to enforce law and order in the territory and to afford protection to the orderly among his Okhamandal subjects, and appealed to the Government of India for assistance. A naval expedition, consisting of several vessels belonging to the then existing Indian Navy, with transports conveying a strong military force, was accordingly despatched from Bombay to reduce the truculent tribesmen to ways of peacefulness. On 6th October, 1859, a heavy bombardment was launched at the fortifications of Beyt, the second most important town in the territory, where the rebels had concentrated their forces, a landing party was disembarked with orders to storm the fort through the breach which the British guns had made.

The attempt to capture the town by escalade failed. The Vaghers fought fiercely, nobly upholding the Rajput tradition of bravery; they poured in a desolating fire upon the storming party and ladder carriers. To add to the difficulties of attack, the rebels had covered the face of the breach with masses of prickly pear and thor bushes, the most effective form of *chevaux-de-frise* possible to devise. The attack was abandoned as hopeless without further bombardment and the storming party retreated to the ships, having suffered severe loss, including that of two British officers. During the following night the defending force abandoned the town, retreating to Dwarka, which had in turn to be bombarded both by land and sea a few days later, before the rebel tribe would make submission.

In passing, it is interesting to note that these two actions are memorable, not only as being the last offensive operations within the confines of India of John Company's Indian Navy, prior to its abolition in 1863, but also as being the last bombardment by British ships of any Indian fortified place. After the pacification of Okhamandal, both sides erected memorials to their dead. The British monument consists of an unpretentious flat-topped tomb in the centre of a tiny walled-in enclosure on the desolate high ground south of the town of Beyt. Graven on the covering slab is a laconic inscription without dedication. The Vaghers were accustomed to erect more ornate memorials, for, like the Rajputs, ancestor cult and veneration of heroes are, or were till recently, living forces in their tribal life. These cenotaphs consist of upright slabs whereon the dead warrior is represented conventionally either on horseback or on foot. Outside the village of Gopi Rajpura, lying opposite Beyt Island on the mainland side of the narrow dividing strait, a group of these stones bears witness to the heroism of the defenders of Beyt in 1859. According to the village headman, the rank

of the hero is shown conventionally by the trappings of the horse he rides, if they are richly caparisoned after the fashion of the chargers of mediaeval knights, the cloth elaborately embroidered and fringed with tassels, he was a man of high rank, a chieftain; if he bestrides a plain saddle, he was a man of inferior status; represented without a horse, the hero was a stripling, as yet unmarried. No village, however poor or mean, is without at least one or two of these memorials; more frequently, there is a series of different ages and designs, indicating cycles of warfare or unrest.

By far the most interesting of these quaint Vagher memorials is one of a numerous group outside the walled town of Aramra, once of considerable importance as the last halting place of Hindu pilgrims on their way to the holy shrine of Krishna across the channel on Beyt Island. On this stone, instead of the conventional horseman, there is carved in strong relief, the representation of a square-rigged, four-masted ship. The vessel has the distinguishing characteristics of a large East Indiaman of the century period ending about 1720. The poop is notably high, the bows low, with a curved stem turned inwards at the head. Two rows of gun ports are clearly shown along the side, while a massive fixed bowsprit rises at a high angle clear of the stem The foremost of the four masts is a short spritmast stepped upon the bowsprit and carrying a square sprit-topsail. Of the foremast, mainmast and mizzen, the mainmast is the tallest. All carry square sails, which, from their positions high up on the masts, obviously represent topsails; the larger lower sails have been omitted by the sculptor in order to provide space for the representation of three warrior figures of disproportionate dimensions, each brandishing a scimitar.

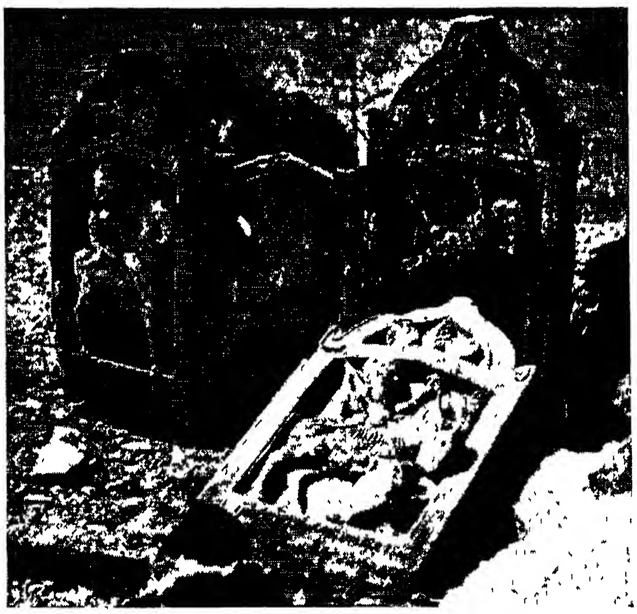
STONES WHICH ARE STILL VENERATED

Many of the memorials stand neglected, but others still receive the homage of their descendants who periodically paint the figures with vermillion This curious treatment accounts for the lack of detail in the stones shown above.

On my asking the significance of this sculptured ship, so unlike any type of Indian sea-craft, the headman summoned a villager of the boat-building caste, people who serve also as seamen on coasting vessels. "This man," he said, "is a descendant of the one to whom the memorial was erected." When the villager arrived, he stated that the hero commemorated was a pirate of great renown, the captain of a pirate ship manned by kinsmen of the Vagher tribe; he met his death during an attack upon a European ship Whether the foreign ship was taken or the attack beaten off, he could not say. He maintained also that the ship represented was the one commanded by his ancestor, but this is manifestly impossible. No Indian pirate on the coast of Kathiawar would put to sea in any but a lateen-rigged ship, and most certainly not in such a large and powerfully armed vessel as is indicated by the sculptured representation, though to build a ship of this type was well within the capacity of Indian shipwrights in the Bombay shipyards. It is much more likely that the intention was to depict the vessel which the Vagher freebooter attacked and probably captured. Cogent reasons in favour of the supposition that the attack was successful are the fidelity of the details—the sculptor must have had ample opportunity to study those of such a ship at close quarters—and the fact that the three men on the deck are brandishing their weapons with every appearance of acclaiming a glorious victory.

The pirate's descendant stated that his ancestor was the fifth life from and including himself. Taking twenty-five years as the average for each of the four generations, together with an extra twenty-five, as my informant was over fifty years of age, we arrive at an estimate of about a hundred and twenty-five years as the period since the pirate's death. This would appear to fix his exploit at some time during the opening years of the nineteenth century. Such a dating is manifestly erroneous; the worn condition of the stone, the ruinous state of the platform on which it stands, and, most decisive reason of all, the antique type of vessel represented, all controvert this conclusion. Family traditions of the kind under question are notoriously unreliable in India; the five lives spoken of are probably a guess, and we must

rely solely upon the evidence afforded by the design of ship shown upon the memorial stone. This has all the outstanding characteristics of vessels built during the hundred years subsequent to 1620, more particularly noticeable in the form and position of the sprit topmast. The sculpture shows this to be stepped at the extreme end of the bowsprit; a jackstaff bearing a flag is also present and it is notably short. Both these features are characteristic of ships of this description—war-ships and armed merchantmen—rigged between 1620 and 1720. The absence of a jibboom further certifies this dating, for this spar was not authorized for the Royal Navy till 1705. The high poop and quarter-deck and the incurved beakhead are also features found in vessels of this period. A transverse bulkhead at the butt end of the bowsprit is another characteristic common to ships of the time named—its presence is clearly indicated in the sculptured figure abaft the incurved beakhead.



HERO STONES AT BEYT.

No village, however poor and mean, is without at least one or two memorials to dead warriors, every place favouring its own distinctive design. More frequently there is a series of different ages and designs, indicating cycles of warfare.

The extreme accuracy of the details is amazing. It attests both the skill of the sculptor and the greatness of his powers of observation; there is nothing crudely conventional in his treatment of the theme—even the shrouds are represented in addition to the major features enumerated. Flags fly from all the mastheads and an ensign is carried at the stern. Such accuracy is incredible unless the sculptor had had ample opportunity to study the details at leisure; and this would be impossible unless the ship had been captured and brought into Beyt harbour by the victorious Vagher pirates. If so, this stone bears silent witness to a fiercely contested sea-fight as well as being a hero's memorial; the death of the pirate chief and probably of two of his lieutenants—for three figures are shown standing on the deck—would be cruelly revenged, and must have entailed a tragic death for those Europeans who were so unfortunate as to survive the capture of the ship. It is a pity that we do not know the full story of this great sea-fight.

Life must have been cheaply held in the old days to judge from the number of hero stones still standing in every town and village. Each place favours its own distinctive design in the details of the sculpture. In some, the warrior carries a lance, in others a sword is brandished in one hand, while, in some cases, a round target is held aloft. Some hold both sword and spear. Whatever other devices may ornament the upper part of the many local memorial stones, conventionally crude figures of the sun and moon are always present, symbolizing the pious hope of the family that the memorial may last as long as sun and moon endure.

Men do not monopolize all the glory of heroic death. The magnificent but sombre legend of the sack of the Rajput fortress of Chitor is still told in Kathiawar with proud enthusiasm; of how before the sortie of the surviving warriors, which marked the closing scenes of the defeat, their women committed *suttee*, throwing themselves upon the flames rather than become the playthings of the conquerors. The memorials to their memory remain to-day. The road which leads to the ruined city is flanked with stones on which the conventional symbol of suttee is sculptured; the flexed arm severed at the shoulder.

To people nourished on such stories, emulation comes naturally, and everywhere in Kathiawar, even outside the most poverty-stricken hamlets, examples of memorial stones have been erected to the memory of devoted wives who committed suttee.

Many of these humble memorial stones to village heroes and heroines stand neglected, but others still receive the homage of their descendants, who periodically visit these memorials to feed the hungry ghosts and to paint the figures with vermillion, the latter an act of veneration similar to that accorded to a deity. This treatment accounts for the lack of detail noticeable in the four stones found at Aramra. But times are changing rapidly, and, with the advent of the cinema, the youths of to-day are better acquainted with the antics of the film comedians than with the deeds of the heroes of their own land.

The Next Step in Ornithology.

By E. M. Nicholson.

In DISCOVERY *for April, Mr. Nicholson stressed the need for organized measures in bird-marking on an international scale, and he now describes a scheme for simultaneous observation around the North Sea which is being put to the test this autumn. Although the project is faced with almost insuperable difficulties, it definitely marks an important step forward in the science of ornithology.*

In common with other sciences, ornithology has passed the stage when it can be carried on profitably upon the basis of a number of more or less isolated enthusiasts, working in what leisure they may be able to devote to it. The intense specialization of the present time has finally exterminated the picturesque Victorian figure of the ornithologist who could still claim to have everything that was known of the subject at his finger-tips. We have already students of migration, of geographical distribution, of flight-mechanics, of plumage and structure, of territory and economics, of courtship, of population, of ecology, and of other equally well-marked branches of research whose methods, vocabulary and results are known to one another or to the general body only to the most vague and unsatisfactory degree.

An Anti-Scientific Tradition.

This complexity, unfortunately, is not the only handicap: the whole tradition of ornithology is strongly anti-scientific. Its very popularity has swamped it for the past four generations with birds'-nesting schoolboys who have only partially succeeded in growing up. Birds have remained for the vast majority a hobby rather than a serious field of work, and this applies not only to egg-collectors, shooters and sportsmen of the old school, but almost equally to the bird-photographers and even the bird-watchers of the new. Camera and field-glass are doubtless more humane weapons than gun and egg-drill, but they do not necessarily involve that essential change of attitude without which ornithology must continue to be an amateur and haphazard pursuit leading nowhere in particular. The passion for chasing rare birds has not been diminished by a growing sentiment against killing them when found; the ambition for adding something to the county list is still dominant Ornithological publications are perpetually inundated by a flood of scrappy records of supposedly uncommon occurrences, submitted on the assumption that someone some time will reduce them to order in a painstaking compilation; an assumption which is rarely justified, since the ordinary worker is happy enough to collect odd bits of raw material, but very reluctant to undertake any systematic task.

No doubt there is more useful scientific work on birds being done now than at any earlier period, but the ornithological machine, like the steam engine, must be judged not by its absolute performance but by the efficiency it attains, and this efficiency is lamentably low. In other words, most of the people concerned are wasting all their time, and practically all of them are wasting a good deal of their time. The problem of reducing this inefficiency, of making ornithology more scientifically fruitful, deserves precedence over all the special problems with which the minority of serious students is confronted.

This central problem resolves itself into a question of organization, for the mass of observers capable of useful work who are not at present engaged on any can only be harnessed to a definite scheme. Any stimulus to individual effort, however well responded to, could only lead to an appalling waste of energy, offset by a small fraction of valuable achievement.

Organizing Bird Watchers.

In advocating the replacement of the detached observer, working on his own by an organized group who collaborate in a definite plan, it is unnecessary to deceive oneself into believing that the process is an unmixed gain. If the individualist were capable of choosing his own line intelligently, mastering the problems outstanding and publishing his results in a manner which would make them generally available, no doubt he would have the advantage of any ordinary combination. But the trouble in practice is that the individualist refuses to be individual. He devotes himself to keeping records of a character which has ceased to be useful since the period of Gilbert White: in order to put an appreciable number of observers on novel and fruitful research, it is necessary to give them guidance. If the bird-watchers of any country were organized on even a narrowly conceived plan, the effect would immediately be, not to stereotype their activities, but to diversify them, so marked is the rut into which the great majority has fallen.

The objections to organization, therefore, are theoretical rather than real. That the ordinary observer is a creature of habit rather than enterprise is inevitable from the circumstances of his life; he has neither scientific training nor the opportunities to keep abreast of his subject, and no one is more ready to recognize how much he might benefit from expert direction within suitable limits. The strength of the demand to be given something useful to do is evidence that the tendency towards a more definite organization of ornithological work is not confined to the scientist, who appeals for more eyes and ears to secure the data which he urgently needs, but is shared by the keen yet untrained lay observer aware of the repetitive and unfruitful nature of his ordinary occupations.

Co-operation Already Tested.

The implications of organization are sufficiently clear. The tendency puts the responsibility for field research principally into the hands of the small minority of trained whole-time experts, and on the imagination, resolution and energy of those experts most of the work of the near future must depend. In bird-marking the process has already reached maturity, and in this special case the machine with the man in control of it subordinates the field collaborator to an extent unlikely to be repeated when census and other joint enterprises reach a similar development. The success of bird-marking proves the spirit of co-operation waiting to be harnessed by leaders commanding the confidence of numbers of observers. Temporarily, and for limited objects, this co-operation has already been tested. The "British Birds" Census of Heronries in 1928 involved the help of about five hundred persons in all parts of the British Isles, and this was a hasty effort with no previous experience and no pre-existing organization to depend upon. No doubt the experiment cuts both ways, and a proportion of those who willingly give valuable help to an isolated inquiry might fail to support more extensive efforts from want of either time or inclination. To develop all possible sources of information without trespassing excessively on the goodwill of those not primarily interested is, in fact, already a serious question for the various biological investigations now in progress. On the other hand, steady application to the solution of various problems in the field readily collects a keen and consistent group of observers who are prepared to help to any reasonable limit, and as the technique is acquired the quantity of correspondence necessary to elucidate difficulties and check mistakes tends gradually to diminish. An obvious parallel is the net of voluntary meteorological stations operated in all parts of the country, and the related phenological reports organized through the Royal Meteorological Society actually link up with the biological problems.

While co-operation on a national scale is still in the experimental stage, with no permanent machinery, a scheme for international combined investigation appears remarkably ambitious. But Dr. Drost, chief of the Ornithological Observatory on Heligoland, has obtained a response which he considers very satisfactory for his plan of simultaneous international observation around the North Sea, and the putting to the test of this project in the present autumn marks an important step forward. The conception of a cordon of observers stretching through Norway, Denmark, Germany, Holland and Belgium to the Channel Coast of France, and back by the North Foreland, Orfordness, Blakeney, Scolt Head, Spurn and the Farnes up to the Orkneys and Shetlands, looks so grandiose that it is surprising to learn that its realization has proved practicable. The intention is to appoint special days between mid-September and mid-October on which certain observations, rendered uniform by the use of a standard schedule, shall be made at as many as possible of the suitable stations round the North Sea. No doubt some of those who volunteered months ago will be prevented from occupying their posts, and the difficulty of ensuring that a number of persons in half-a-dozen different countries, mostly speaking different languages from headquarters, shall all function at the right time without leaving any serious gaps is in itself enough to deter all but the most resolute of organizers.

Serious Obstacles.

In the Census of Heronries, which lasted several months, there were serious obstacles in arranging for various areas to be adequately covered, while in others there was ample response for duplicate or triplicate returns.

A census of all transient and resting species and individual birds, on one day at fixed hours, is by no means as simple as it sounds. Most of the birds met with at any point on the North Sea shore at this season might equally well be transient or local native stock so far as their species goes, and it is not clear how anyone can feel satisfied to distinguish between the two unless he has done some continuous observation of an intensive sort at the same point, in order to get to know which are the resident or native birds, before he proceeds to sort out the transients. An indefatigable observer has sent me from time to time the results of

protracted census work on a patch of land near the Sussex coast: although he has secured exact counts several times a month under all sorts of conditions for more than three seasons, one must still hesitate to say what the resident stock is from which transients would have to be deducted. In November, 1927, for example, the green woodpecker occurs in only one count out of ten, and the little owl in two, but it is unlikely that either of these are in any ordinary sense migrants; they are probably birds with an extended foraging range. Stonechats, up to four individuals, occur on seven occasions, but in February, 1928, none appear till the 25th, and in March only two odd birds occur in eight counts. In September-October, 1928, they are represented in all ten counts by between two and thirteen individuals. In January-February, 1929, there are none in ten counts. In March, there are again two odd birds. In September none are found, but in October, there are always between one and two.

Defining Transients.

Here in these observations by Mr. J. F. Thomas is contained probably the only full and accurate material in this country on which a definition of transients could be based, and the more it is considered the more arbitrary any definition seems to be. The idea that on any given area there will be found a certain number of birds which belong there and are always present, and a residue which do not belong—the transients—is, unfortunately, not confirmed by statistical work. In fact, it can only be by chance that any two counts of the same area give identical results. Looking at the subject from a very broad standpoint, it may be possible to distinguish the bird population of a country or a region from the migrants intruding into it, but on a closer scrutiny there is no such distinction: the bird population of any ordinary area is constantly changing not merely through migration but through readjustments of territory, seasonal supplies of food, death and colonization, and the countless short-distance wanderings of local birds. On the other hand, when Dr. Drost's scheme aims as an alternative at recording migration in progress, with directions of flight and so forth, it meets the well-known difficulty that migrants will often diverge from their course to approach a ship, lighthouse or piece of land, and so upset any deductions. Since they naturally see such conspicuous objects before they can be seen from them, the exhortation to record data about changes of direction and steering towards islands, capes, and other landmarks appears decidedly optimistic.

The scheme of an international net of observers round the North Sea is attractively ambitious but dubiously feasible; it seems improbable that many of the data will definitely link up as they are intended to, and the margins of error in the observers and their subject must be so serious that if they are adequately discounted the residue of proved unambiguous facts must be remarkably small in proportion to the effort involved. In this respect the plan contrasts with a ringing campaign or a census where, provided the observers and the scheme adopted are not seriously inadequate, results are definitely assured in proportion to the response, and the risk of weather conditions or absence of movement at the prearranged moment, or complicating factors of other kinds, upsetting the scheme is practically ruled out. The great attraction of the North Sea net is the hope of being able to draw migration sketch-maps comparable to the weather sketch-maps now published daily for the northern hemisphere. The comparison emphasizes the shortcomings of the scheme, since meteorological data are readily taken by routine on similar instruments under strictly comparable conditions, and are of essential importance to large numbers of authorities on sea and land, whereas bird movements interest only a minority working in limited leisure, cannot be continuously studied on a large scale, give far more negative results, and are extremely susceptible to purely human variations and errors in recording them.

A Convenient Unit.

While the value to science of the North Sea project remains to be shown, its value in advancing organization for field work ought to be considerable. It has the merit of emphasizing the fact that, for ornithological purposes, the North Sea basin makes a convenient unit, with the same general avifauna and, in all the countries concerned, a considerable and growing number of available observers. In all these countries it would already be feasible, for example, to take an international simultaneous census of heronries on the model used here in 1928, and in all except, I believe, Norway, a more or less satisfactory survey of the heronries has already been independently carried out. For migration, an international effort to develop ringing and trapping stations would probably prove more fruitful than observational methods; concentration on such species as the fieldfare, redwing, brambling, hooded crow, starling, skylark, and other characteristic North Sea migrants would undoubtedly solve many outstanding problems. Co-operative studies of the fertility of widespread species in the same season over a large part of its

(*Continued on page* 338.)

The Greenland Ice-cap Expeditions.

By F. Debenham, M.A.

Director of the Polar Research Institution, Cambridge University.

The British Arctic Air Route Expedition is unique, not only for the youth of its members, but also because it is the first British expedition to spend a winter in the Arctic for over thirty years. The value of the meteorological results will be considerably increased by the fact that a German expedition with similar aims is in the field at the same time, and such co-operation as is possible has been arranged.

Last year our attention was directed towards the Antarctic, following the expeditions of Rear-Admiral Byrd, Sir Douglas Mawson, Sir Hubert Wilkins and the Norwegians. This year the Arctic is all too vividly in our minds on account of the discovery of the tragic relics of the Andrée expedition, and hardly less so because an attack is being made upon the problems of Greenland by at least two major expeditions. These expeditions have set out to find out more about the Greenland Ice-Cap, that vast sheet of ice which covers over ninety per cent of the island to an unknown depth.

The Main Problems.

The questions which scientists ask themselves about this ice-cap are not abstruse, in fact they differ little from those which a child would put quite naturally: how thick is the ice-sheet, how did it get there and can one walk on it, live on it, and land on it in an aeroplane? These are the main questions to be answered by explorers, though naturally they assume a somewhat more complicated form. Thus, before one can say whether an aeroplane may make use of the plateau, one must know many other things besides the average condition of the actual snow surface, such as the temperatures to be endured, the force and direction of prevalent winds, the visibility, and so on. Moreover, since the ice-cap itself is comparatively inaccessible, any future air ports would be on the fringe of ice-free country not covered by the ice-cap, and this requires examination and surveying. Both the German and the British expeditions, therefore, are doing work which is in the nature of reconnaissance, with the possibilities for air routes over Greenland as the chief object.

It is over thirty years since a well-equipped expedition from England spent a winter in the Arctic, and for that reason as well as for certain other rather unique characteristics the British Arctic Air Route expedition will claim our attention first. It is somewhat unusual, for instance, to hear of a large expedition being led by a young man in his early twenties, who, moreover, has already led two small expeditions, one to Spitsbergen and one to Labrador. That his companions, fourteen in number, should also be youthful is perhaps a corollary of the first statement, but their average age is one to surprise the polar explorer of the past. It has even given rise to the usual aphorisms on youth and inexperience, but these aphorisms and doubts do not come from those who have actually met Watkins and his companions and have observed the spirit which permeates that expedition.

As is generally the case with British expeditions, a shortage of funds has somewhat limited their scope, and more purely scientific investigations have had to be sacrificed to some extent to the main purpose of the expedition, a reconnaissance for an air route over the southern third of the Greenland plateau.

Early Plans.

Transported with considerable cramping and discomfort by Shackleton's old ship, the *Quest*, the expedition has now erected its main base on the mainland behind Angmasalik, the nearest inhabited part of Greenland to Iceland. One party has made a good journey on to the ice-cap, over a hundred miles from the coast, and has left there a subsidiary base with two men for meteorological work. The ship has gone northwards to assist in a rapid survey of the coast and immediate hinterland, assisted by aeroplane photographs. By the time this article is in print the *Quest* will be back in Europe and the expedition will be back at headquarters. Judging from the spirit of the leader, however, there will be very little sitting still at the base, and his plans include long journeys over land and ice-cap by means of dog sledges, always with surveying and meteorological observations as the main objective. The expedition includes at least four capable surveyors, two professional air pilots and one or two amateurs, several who are capable of making the routine meteorological observations which are required, a qualified geologist,

a wireless expert and a doctor. Although Greenland has been crossed in four places, the journeys have been made in haste and we still know comparatively little about the surface of the ice-cap. It is Watkins' intention to try and make a longitudinal traverse of part of it which will determine its general contour in that direction.

The German Expedition's Aims.

The German expedition, while having the same general aims, is quite different in other respects. It is very much larger than the British expedition and, though it has no aeroplanes, its transport methods are much more complete, including two motor sledges, twenty-five Iceland ponies, and a hundred dogs. It is commanded by a scientist of note, Professor Alfred Wegener, famous for his theory of Continental drift and an explorer of considerable experience in Greenland, which he crossed with Dr. Koch as long ago as 1913. He has with him a staff of twenty scientists, some of whom are, like their leader, of international repute.

Their plans are correspondingly more comprehensive than those of the British expedition and include gravity surveys, determination of the thickness of the ice-sheet by seismological apparatus, and a very complete programme of meteorological observation. No less than three stations for the winter are planned, one at each end of a route across almost the broadest part of Greenland and one at the summit of the ice-cap. Such an ambitious programme demands very careful organization and very sound transport, but there seems no reason to doubt that these are available, and the results to be obtained should inaugurate a new era in the scientific exploration of the polar ice-caps. Commencing operations from the western side of Greenland instead of the eastern, the Germans were in the field early this summer and propose to continue for another full year.

It will be seen, therefore, that the two expeditions are curiously complementary while showing marked contrasts, and the value of the meteorological results in particular is greatly increased by the fact that they are in the field at the same time. Moreover, such co-operation as is possible between the two has been happily arranged. The spectacle of an expedition of young Englishmen without great experience co-operating with one of considerably older Germans on the same general problem of the nature of the Greenland Ice-Cap and its weather, and the feasibility of using Greenland for air routes between the Old and the New World, is one which certainly appeals to the polar explorer, who has always been ready to be international in spirit. It will, indeed, interest everyone to follow the fortunes of these two ventures.

And how far will our primary questions be answered as a result? Professor Wegener with his seismological and gravity apparatus will tell us the thickness of the ice-sheet. Watkins and his energetic companions will tell us something of its profile in a north and south direction of which at present we know nothing. Their combined results will assuredly tell us much more than we knew before about life on the ice-cap itself, for so far only a small party belonging to Professor Hobbs' expedition from Michigan has spent a winter on the plateau, and they were not in a truly representative part of it. Their meteorological records should enable them to discover the possibilities for flying at various seasons, and Watkins' surveys in particular should point the way to possible air ports of the future.

Origin of the Snow.

Perhaps the most baffling question of all is the origin of the snow which forms the ice-cap. Various theories about continental ice-caps and permanent anticyclones have attained prominence of recent years, and the final proof of any one of them rests with the meteorologists and depends very much upon the sort of measurements which will be made at the British and German bases on the ice-cap during next year. Two important elements in the problem are the rate of wastage by evaporation (ablation) of the snow on the surface, and the rate of movement of the ice mass towards its edge. Measurements of the rate of glacier movement on the west coast have already been made by Nordenskiold and others, including Wegener himself, and it is hoped that Watkins will be able to do the same for the east coast ice. A host of minor problems will be met with, not the least important being those of a personal nature. No one has yet attempted to live at high altitudes on a continental ice-cap, motor tractors have not been tried under such conditions, and last but not least the flights by Watkins' pilots over the ice-cap in small machines will be different from anything that has been done in the northern hemisphere yet.

It will be remembered that there is to be an international assault on the meteorology of the Arctic regions in 1932, and this pioneer work on the ice-cap should be invaluable in planning that campaign as far as Greenland is concerned. When youth and experience both take a hand in a great problem, the world has a right to expect great things, and readers of *Discovery* will have watched with interest how fortune has treated these two expeditions.

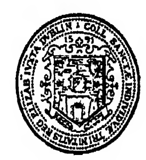
British Universities To-day : (8) Dublin.

By Gilbert Waterhouse, Litt.D.

Secretary to the University Council and Member of the Board of Trinity College.

Founded by Queen Elizabeth as a residential university in the tradition of Oxford and Cambridge, Trinity College, Dublin, has been the centre of intellectual life in Ireland for nearly three hundred and fifty years.

At least three ineffective attempts were made in the fourteenth and fifteenth centuries to establish a university in Dublin. Then, in 1585, an old project of associating a university with St. Patrick's Cathedral was revived, but had to be abandoned owing to the opposition of Archbishop Loftus. No further definite step was taken until 1590, when a group of influential citizens, headed by Henry Ussher, Archdeacon of Dublin, Luke Challoner, and two Scots, James Fullerton and James Hamilton, masters at the Grammar School, addressed a petition to the City Council, which had long been well disposed to the establishment of a university. The Council undertook to make representations to the Lord Deputy, Fitzwilliam, and more particularly to facilitate the scheme by providing a suitable site. The Archbishop and the Lord Chief Justice added their recommendations to those of the Lord Deputy, the royal sanction was immediately accorded, and by Letters Patent of 3rd March, 1591 (commonly called "The Foundation Charter") Queen Elizabeth founded the "Collegium sanctae et individuae Trinitatis juxta Dublin" to be "the mother of a university."



Early Developments.

William Cecil, Lord Burghley, was appointed Chancellor, and Archbishop Loftus, Provost. A small endowment was granted but the funds for the erection and equipment of the necessary buildings were raised mainly by public subscription in Ireland The foundation stone was laid by the Mayor of Dublin, Thomas Smyth, on 13th March, 1592, and the College was opened to students in 1593. The original number of students is unfortunately unknown, but it rose from 65 in 1613 to 472 in 1704, 933 in 1792, and to 1,300 in 1886. In 1913, the number was 1,285, of whom 211 were women. During the War, the response to the call to arms—a response which was entirely voluntary—caused the number of men students to drop to 535. There was a temporary return to the pre-War total in 1919 and 1920, when several hundred ex-service students resumed their studies, but the revolutionary period and the progressive impoverishment of the country caused a further decline to 936 in 1924. With the return to more settled conditions, numbers have steadily risen to 1,309 in 1929-30. The midsummer entrance for 1929 (158) was higher than in any year, with one exception, since the famine of 1847.

The original endowment of Elizabeth was generously supplemented by James I, and in 1637 Charles I granted a new Charter, which forms the basis of the present Consolidated Statutes of Trinity College and the University of Dublin. The Foundation Charter of Queen Elizabeth appears to have contemplated a possible multiplication of colleges on the lines of Oxford and Cambridge. However that may be, all attempts to develop in that way have failed, and for practical purposes "Dublin University" and "Trinity College" are synonymous terms. The framework of a university was undoubtedly created in 1591 by the appointment of a chancellor, by provision for the appointment of a vice-chancellor and proctors, and by the regulations for the conferring of degrees, but the primary executive authority was vested in the Provost, as head of the College. The power of appointment to the provostship originally rested with the fellows but passed to the Crown under the Charter of 1637. The chancellor is appointed for life by the senate. The vice-chancellor is appointed by the chancellor and presides, in the absence of the chancellor, at commencements or other meetings of the senate. This body consists of all doctors and masters who keep their names on the books of Trinity College. It is a body corporate distinct from the College, and is the final authority in all matters relating to the institution and conferring of degrees. The caput of the senate consists of the chancellor (vice-chancellor or pro-vice-chancellor), the provost, and the senior master non-regent, who is elected annually by the senate. Any member of the caput may veto any proposed grace for a degree.

The regulation of courses and examinations precedent to degrees (except in Divinity) and the nomination of the University professors for appointment (with

certain exceptions created by Act of Parliament or by the directions of private founders) are the concern of the University Council, a small body composed mainly of members of the teaching staff, together with representatives of the senate and of the Board of Trinity College. All matters relating to the Divinity School are dealt with by the Divinity School Council, on which the bishops of the Church of Ireland are represented. The provost presides over both the University Council and the Divinity School Council. All the acts of these bodies require the sanction of the Board of Trinity College, which is the supreme authority in all matters of administration, discipline, and finance. It consists of the provost, the seven senior fellows, two representatives of the junior fellows, and two representatives of the University professors.

The domestic cares of a residential university are innumerable. Rooms in College are naturally in great demand, but only about three hundred undergraduates can be accommodated. The remainder live in registered lodgings or with their parents, if their homes are in Dublin or its neighbourhood. A hostel for women, Trinity Hall, was opened in 1908 and now, after extension, accommodates about sixty students. About three hundred undergraduates dine in Hall daily, luncheon is served at a special buffet during term, and the Dublin University Co-operative Society caters for all ordinary requirements. Indeed, life in Trinity offers many attractions not easily found elsewhere. The spacious grounds form an oasis of some thirty acres in the heart of the city, provide the College clubs with ample facilities for cricket, football, hockey, and tennis, and still leave room for quiet walks, for flowers and shrubs and stately trees.

A Varied Curriculum.

In Trinity Week, about the middle of June, the College races provide one of the principal athletic and social functions in Ireland. Similarly, there is ample scope for intellectual and oratorical activity in the College Historical Society, founded in 1770, the University Philosophical Society (1853), the Theological Society (1830), the Choral Society (1837), the Classical Society, and others of more recent foundation. There are advantages also in easy access to the theatres, galleries, libraries, and other institutions of a capital city, while the study and practice of law and medicine in particular are simplified by proximity to the King's Inns and the great Dublin hospitals.

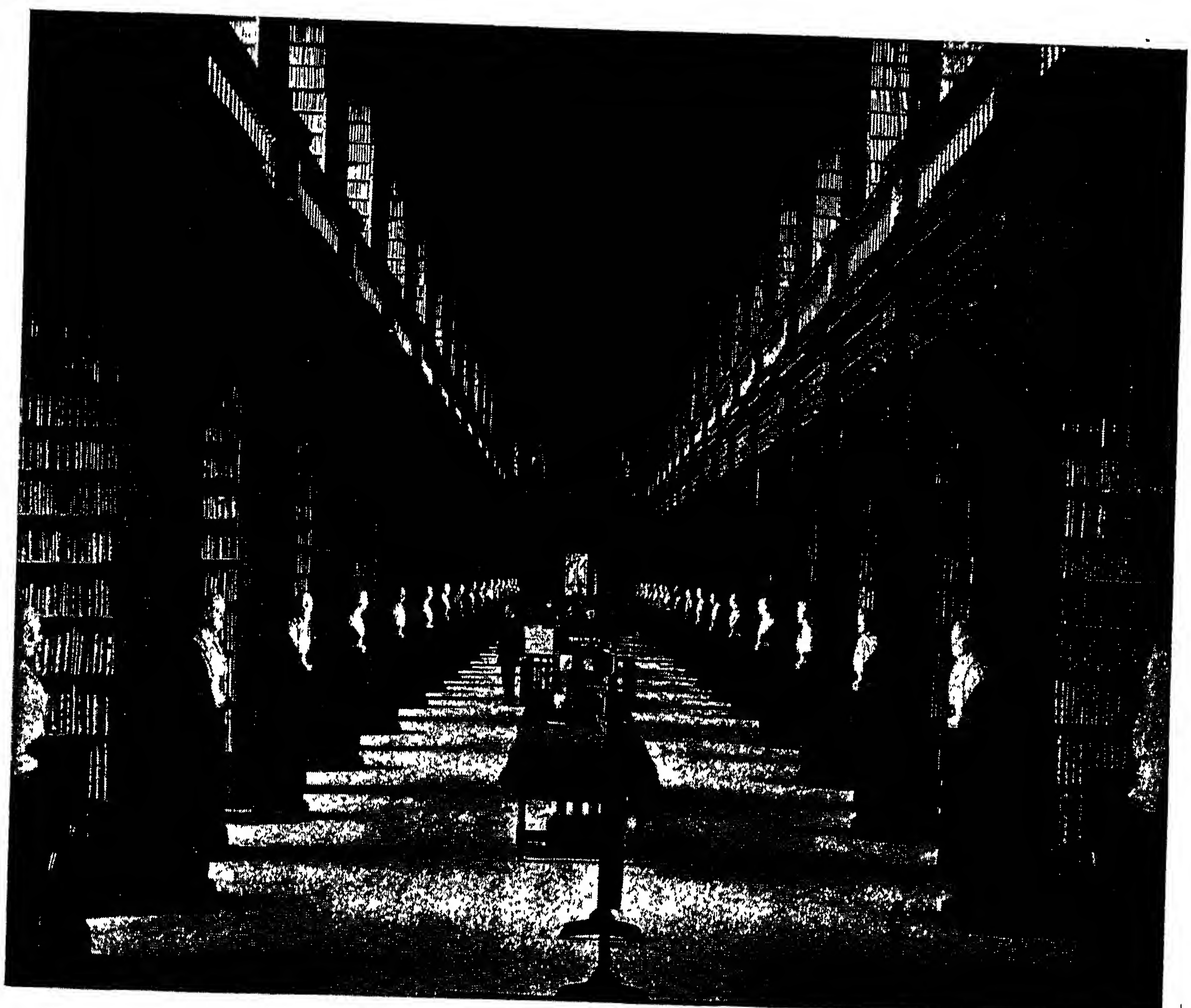
With the passing of the centuries, the curriculum of the University has undergone the same changes as in other ancient seats of learning. Sweeping reforms were made during the provostship of Bartholomew Lloyd (1831-37), who opened a new and progressive stage in the history of the College. The School of Engineering, the first in any university in the United Kingdom, was opened in 1842, and degrees in engineering were created in 1872. In 1855, when open competition for the Indian Civil Service was introduced, prompt steps were taken to provide the necessary instruction in oriental languages, with the result that hundreds of Dublin graduates have found, and continue to find, their careers in the Imperial services. This widening of academic studies has proceeded so far that students can now obtain degrees not merely in Divinity, Law, Medicine, Philosophy, Classics, and Mathematics, but also in Modern Literature (professorships of French, German, Italian and Spanish were founded in 1778), Oriental Languages, Celtic Languages, Music, History and Political Science, Engineering, Natural Science, Experimental Science, and Commerce.

Financial Needs.

Like other academic bodies throughout the world, the Board of Trinity College is constantly engaged on the task of apportioning its limited resources to ever-increasing demands for staff, buildings, and equipment. The needs of the University, like those of Oxford and Cambridge, were the subject of an inquiry by Royal Commission in 1920, under the chairmanship of the late Sir Archibald Geikie. The financial recommendations of that Commission were, in part, incorporated in the abortive Government of Ireland Act of 1920, which appeared to guarantee to the University of Dublin an annual subsidy of £30,000. This cheering prospect proved to be only a mirage, and the guarantee disappeared with the Act. The effects of this disappointment were acutely felt for some years, but there are now signs that relief may come from another source. In 1927 an influential Committee of graduates, reverting to the old maxim that self-help is the best help, established the Trinity College (Dublin) Educational Endowment Fund as a thank-offering to the College for the education received within its walls. It is hoped that this fund, which takes the form of a perpetual trust, will in the course of time assist the University to maintain that academic independence which is the first condition of a healthy existence. The University of Dublin, subsisting entirely on its endowments and on its fees, thus remains one of the few free universities of Europe, acknowledging no obligation save to the cause of learning and offering equal liberty to all who seek its instruction with good will.

Trinity College owes much, nevertheless, to the

THE QUADRANGLE, TRINITY COLLEGE, DUBLIN.



AN INTERIOR VIEW OF THE LIBRARY.

generosity of governments in the past. The Library, the oldest and largest of the existing buildings, was erected in the years 1712 to 1724 at a total cost of £17,000, of which £15,000 was provided by Parliament. The collection of books had its origin in a subscription of £1,800 from Her Majesty's army in commemoration of their victory over the Spaniards at Kinsale in 1601. The private collection of Archbishop Ussher, consisting of ten thousand volumes, with many valuable manuscripts, including the priceless "Book of Kells," was also a gift from the officers and men of the English army in Ireland. Among the more important additions to the Library since 1660 are the collections of Archbishop Palliser, Bishop Stearne, Dr. Claudius Gilbert, and Baron Hendrik Fagel. In common with the British Museum, the university libraries of Oxford, Cambridge, and Wales (Aberystwyth), and the Advocates' Library of Edinburgh, Trinity College enjoys the privilege of receiving a free copy of every book published in the United Kingdom.

The cost of the magnificent West Front of the College (1759), and the adjacent Parliament Square, was largely defrayed by a grant of £40,000 from the Irish Parliament. The two wings of the square are terminated with symmetry and dignity by the Public Theatre or Examination Hall (1787) and the Chapel (1798). Indeed, few universities can offer such a variety of architectural interest as Trinity College, but space permits only a brief reference to the unique Museum Building (1857), the Graduates' Memorial Building, erected by subscription to commemorate the Tercentenary (1893), and the Physical and Botanical Laboratories erected and equipped by the munificence of the late Chancellor, the first Earl of Iveagh.

An Undeserved Reproach.

At some time in the beginning of the nineteenth century, Trinity appears to have been reproached as "the silent sister," as one that contributed nothing to the intellectual life of the country, a charge which drew from Dr. Mahaffy the witty comment: "Among all Irish institutions, probably the only one ever accused of silence is the University of Dublin." It is at least open to doubt whether Oxford and Cambridge were in much better case during a period of war, rebellion, reaction, and unrest not unlike the times through which Europe has recently passed. At any rate, the record of Trinity College, as shown by the catalogue of its great men, will bear comparison with that of any other university, British or foreign. Among poets and men of letters it claims Swift, Congreve, Farquhar, Goldsmith, and Moore; among scholars Ussher, Ware, Dodwell, Malone, Hincks, Whitley Stokes, Lecky, Mahaffy, Tyrrell, Dowden, and Bury; among philosophers Berkeley; among mathematicians Hamilton and McCullagh; among scientists Molyneux, Lloyd, and Fitzgerald; among theologians Magee and Salmon, among physicians Stokes and Graves; among statesmen and orators Burke, Grattan, Flood, Plunket, Curran, and a host of others. The past is full of splendour only, its troubles and dangers are forgotten. And what of the future? How will Trinity College face the changing times? The answer must be: exactly as it faced the changes of the past, that is, by the steadfast discharge of a university's supreme function—by single-minded devotion to the advancement of knowledge.

The Next Step in Ornithology.

(Concluded from page 332.)

range offer an ideal subject for international work. But all such projects are hopeless without whole-time research workers to keep them going and to publish the results in a form which will make them generally available. The time when such operations may be left to chance and the goodwill of a few overworked men doing what they can in their spare time is past. Ornithology urgently needs a general staff to direct and make effective its efforts. The ambition is not a visionary one, and there are definite prospects that it may soon be realized. By the time this appears in print a scheme of ornithological research with a strong economic bias will already be in working order in this country, with sufficient grants to guarantee its continuance for a minimum period of three years. Only difficulties of raising funds stand in the way of organizing field work on a satisfactory scale without further delay.

To sum up, the long leisurely collecting and arranging stage in ornithology has continued for the past two centuries on the narrow lines laid down by pioneers, and has in many respects served its purpose so that it can do nothing further of importance without merely repeating itself. In order to remedy this shortcoming it is necessary for the specialists to take active steps in directing the energies of all bird-watchers to the most fruitful problems, and the growing complexity of these problems demands some closer relationship than that of a group of isolated workers in the same field. Both the specialists and the ordinary spare-time bird-watchers show every sign of being prepared for such a development and capable of making a scientific success of it.

The British Association Meeting.

By Major A. G. Church.

The addresses delivered at the Bristol meetings of the British Association were as illuminating and as varied in character as in previous years. A selection of the papers is summarized by our special correspondent.

THE Bristol meeting of the British Association, which has just concluded, has further demonstrated the fact that those responsible for its organization realize that one of the main functions of the Association, if not the principal one, is to encourage in the people of this country a wider appreciation of the part played by science in national and imperial affairs; and this task is not easy. Success in any one of the thirteen fields of scientific enquiry, into which the Association has found it necessary to divide its labours, demands a high degree of specialization. It is inevitable that some of the specialist members of the Association regard its annual meeting as a summer session of the particular learned societies to which they belong. Their enthusiasm for their own subjects inclines them to forget that the Association was founded to bring the various specialized branches of science into closer contact, to enable them as specialists to present the results of their studies in a form intelligible to those working in other fields of inquiry, and to provide them with abundant opportunities for intellectual excursions.

The President's Appeal.

This year the task of presenting a synoptic view of science based upon a lifework of study in a highly specialized field fell to Professor F. O. Bower, the first botanist for many years to occupy the Presidential chair. This he did in an address on "Size and Form in Plants," a thesis which enabled him to make a plea to biological students for more assiduous attention to morphological study as the essential foundation of experimental work in biology. He reminded his audience that it was the host of workers who patiently observed and compared the facts of individual development, particularly in plants of low organization, who prepared the field for the magic touch of Darwin to produce the theory of descent. This is not the place to summarize the whole of Professor Bower's address; it must suffice here to say that he communicated to his audience, through the beauty and simplicity of the illustrations he used, some of his own enthusiasm for an attitude towards biological studies which has for some years past been regarded as unnecessary drudgery by some representatives of the modern school of experimentalists.

The President concluded his address by referring to the gloomy prophecy made in 1898 by Sir William Crookes, on the occasion of the last meeting of the Association in Bristol, that by the year 1931 there would be a world food shortage. That this catastrophe had been averted was due to the successful application of the results of botanical and other scientific research to the production of the necessaries of life, a fact which alone justified the creation and expansion of research services throughout the British Empire.

Government Research.

Professor Bower's necessarily brief sketch of the ways in which the various governments of the Empire are fostering research was elaborated most appropriately by no fewer than five official members of imperial research institutions, each of whom occupies the position of president of a section of the Association. They are Dr. F. E. Smith, secretary of the Department of Scientific and Industrial Research; Dr. G. T. Morgan, director of the new Government Chemical Research Laboratory; Dr. A. W. Hill, director of Kew Royal Botanic Gardens; Dr. W. T. Calman, keeper in zoology at the Natural History Museum, and Dr. P. J. du Toit, director of veterinary services and animal industry for the Union of South Africa. That five out of thirteen section presidents should be in the direct employment of the government is some indication of the place which government research institutions occupy in the world of science.

In his address to the Mathematical and Physical Section on "Theories of Terrestrial Magnetism," Dr. Smith pointed out that our knowledge of the cause of the earth's magnetic field is little more than conjectural, for, of the theories advanced, all that have been put to practical test have been found wanting in some respect. The subject, of course, had a direct bearing on radio communication, and its further elucidation depended on the accuracy of observations made over the whole world during magnetic disturbances. Dr. Smith therefore appealed

for international co-operation in the adoption by many of the first-class magnetic observatories of a programme including simultaneous observations with similar instruments of great sensitivity.

The need for such international co-operation was supported by Professor Appleton, who, together with Mr. Watson-Watt, Monsieur Bureau (France), and Dr. Connolly (America), took part in a discussion on the "Meteorological Relations of Atmospherics," in which it was pointed out that the divergent views of certain British and American physicists on the origin of atmospherics was probably due to the dissimilarity of the instruments used for observation. In this connexion Professor Appleton suggested that the universal use of the oscillograph, which had been designed by Mr. Watson-Watt and his colleagues at the Radio Research Station for the location and intensity of atmospherics, would solve the problem of the origin of these disturbances.

Chemical Investigations.

Dr. Morgan's presidential address to the Chemical Section dealt with the results of the six major investigations which have been carried out under his direction at the State Chemical Research Laboratory at Teddington. The production of synthetic resins of high dielectric capacity have been obtained from formaldehyde and the cresols and xylenols, and fresh information has been disclosed concerning their chemistry. A systematic study has been made of the chemical constituents of the tar derived from low temperature carbonization, a result of which has been the isolation from this and other tars of four chemical groups of resins. Investigations have been made on the effect of high pressure on chemical reactions, and many members of the homologous series of alcohols, aldehydes, fatty acids and esters have been synthesized by the interaction of carbon monoxide and hydrogen in contact with various catalysts at high temperatures and pressures.

Other investigations described included those on the corrosion of metals either in air or when immersed in water or salt solutions, resulting in two noteworthy discoveries regarding the composition of the green patina which develops on exposed copper surfaces. Work on the base-exchange (zeolite) method of water softening was also described. Of all the work in progress at the Laboratory, however, that being carried out in collaboration with the chemotherapy committee of the Medical Research Council may have far-reaching effects on the preparation of drugs, essences and perfumes, on a commercial scale in this country.

Under the somewhat forbidding title "Problems in Taxonomic and Economic Botany," Dr. A. W. Hill delivered an illuminating presidential address to the Botany Section. He strongly supported Professor Bower's plea for the systematist by emphasizing the importance of accurate records in connexion with work on genetics, hybridization, acclimatization, and the influence of soil content on plant growth. In his survey of the work carried out under his direction at Kew he mentioned that it was from records compiled there upon information obtained from all parts of the world that it had been ascertained that the musk plant (once a feature of our gardens in England, and with which the musk scent was uniquely associated) suddenly and almost simultaneously, wherever it was grown throughout the world, had ceased, a few years ago, to give out this scent, a phenomenal occurrence which indicated a fascinating subject of inquiry.

Dr. Calman's presidential address to the Zoology Section on "The Taxonomic Outlook in Zoology" was a further and closely reasoned appeal for more and better work on systematics, from the lack of which, he asserted, much current work and speculation in biology has suffered. Dr. Calman's critical examination of Professor Przibam's theory of apogenesis, which suggests that every species has developed, independently of all others, from a distinct species of protozoan, with its implied doctrine of special creation at one remove, was a particularly challenging feature of his address.

Veterinary Achievements.

Dr. du Toit, upon whom the mantle of Sir Arnold Theiler of rinderpest fame has descended, gave a general outline of some of the most notable achievements in veterinary science in recent years, in collaboration with investigations in other sciences. On all fronts the campaign against diseases in domesticated animals is being waged with ever-increasing success, due to scientific methods supplanting the older empirical methods. Progress is being made in the treatment by drugs of animals infected with disease transmitted by tsetse flies, the scourge of African cattle and the menace to African civilization; the fight against diseases caused by piroplasms is now being waged with every hope of success now that the role played by the "tick" in their transmission is fully understood. Great advances have been made in connexion with the groups of diseases due to ultra-visible viruses and recent studies have led to the evolution of methods for their eradication or cure; the eradication and control of diseases caused by external parasites and poisonous plants; the effect of mineral deficiencies

in the soil on animal nutrition; and in animal breeding.

In his address to the Geology Section on the "Geological History of the Bristol Channel," Professor Jones provided a sound basis for the field studies of visiting geologists. Of particular interest was his statement that "comparison of the physical features in relation to axes of folding leads to the conclusion that those in the west of England are together almost a mirror image of those in the east." Sir Ernest Moir's address to the Engineering Section profusely illustrated the interdependence of the engineer on the science of the physicist, the physiologist, the bacteriologist, the economist, and the all-important science of finance. The most technical of the presidential addresses was that of Professor Raper to the Physiology Section on "The Synthetic Activities of the Cell," the popular exposition of which is admittedly exceedingly difficult. To the Anthropological Section its president, Dr. Harrison, of the Horniman Museum, presented his conception of the evolution of material culture in an address which combined in the happiest way lucidity, scholarliness and charm. Professor Roxby, president of the Geography Section, dealt with the scope and aims of Human Geography, and Professor Valentine, who addressed the Psychology Section on "Foundations of Child Psychology," indicated the scope of the future activities of investigators in their respective branches of study.

Higher Education.

Neither Lord Eustace Percy, president of the Education Section, nor Professor T. E. Gregory, president of the Economics Section, were at Bristol to deliver personally their respective addresses. Lord Eustace was in America, and Professor Gregory was with Sir Otto Niemeyer in Australia. The former's contribution on "A Policy of Higher Education" was a fuller exposition of views he had already outlined in Parliament on the compulsory raising of the school-leaving age. He challenged the truth of the assumption that full-time schooling up to sixteen years of age must be good for everyone, and that all we require is a sufficient variety of schools and curricula, an assumption which he asserted ignores the fact that higher education worthy of the name is the very antithesis of the "forcible feeding" largely and necessarily prevalent in the elementary stage. At the same time he agreed that there is an increasing demand in the country for labour involving some measure of abstract thinking and planning, which points to longer schooling. This demand, he suggested, can best be met by the development of five-year courses for children between eleven and sixteen, the first three in full-time schools and the last two either in full-time or part-time schools according to the pupil's needs.

Professor Gregory's subject, "Rationalization and Technological Unemployment," was equally controversial, although presented less provocatively. Rationalization, he suggested, is not a remedy for unemployment. On the contrary, it might increase its volume. But the rationalization movement was international in character and this country certainly could not contract out of its consequences. The consequences might be that the occupied population of the future would be less industrialized than in the immediate past. In this transition a grave transfer problem was involved, and therefore the first and most obvious ameliorative measure must be an increase in the mobility of the working population.

Popular Lectures.

As usual, the Council of the Association arranged for a number of popular and semi-popular public lectures on subjects of general interest in the place of meeting and neighbouring towns. These included lectures on "The Sun" by Mr. Greaves of the Greenwich Observatory; "Price Level and Scientific Control" by Sir Josiah Stamp; "Breathing under Difficulties" by Professor Winifred Cullis; and an address by Dr. Stefannson on "Bristol and the Exploration of Greenland." In the first evening discourse to the members of the Association, Professor Appleton gave a characteristically vivid and clear exposition of an exceedingly difficult subject, "Wireless Echoes," phenomena which are annoyingly familiar to most users of wireless sets, but which open up a field of inquiry of intense interest to physicists. Dr. R. E. Slade, at the second evening discourse on "The Nitrogen Industry and our Food Supply," gave an account of the commercialization of the process for extracting nitrogen from the atmosphere, with particular reference to the output from Billingham of fertilizers based on this process, and gave statistics to show how the synthetic products had, in a few years, become the preponderating factor in the world supply of nitrates.

There were rather fewer joint discussions than usual between sections, only four taking place. In two of these, one on the "Relation between Past Pluvial and Glacial Periods" and the other on "Primary Colours," the various expert contributors were inclined to be either too technical or too discursive. Very different was the discussion between the Engineering and Physiological Sections on

" Air Pressure Variations in Engineering Works and their. Physiological Effects," in which views were exchanged between naval and marine engineers in charge of salvage operations involving deep-sea diving, engineers engaged in tunnelling, and physiologists and medical men engaged to safeguard personnel subjected to high air pressures. The discussion on " Mineral Elements in Plant Nutrition " between the Botany and Agriculture Sections was not only intrinsically interesting but fruitful in indicating the lines on which further advances in knowledge might be made.

Individual Sections.

In the individual sections a number of discussions took place. In addition to one on " Atmospherics," to which I have already referred, the Mathematical and Physical Section discussed " Flow in Gases," where the various methods of its determination were under review, another following a series of papers on " The Solid State," which was the occasion for Sir Ernest Rutherford's announcement that experimental evidence was now available to prove what had been for a long time suspected, that the streams of apha-particles emitted from various radio-active elements were complex in character. This announcement, Sir Oliver Lodge remarked, would throw light on the constitution of the atomic nucleus. In this connexion, the paper by Dr. P. A M. Dirac on " The Proton," in which he put forward an hypothesis of the proton which could be reconciled with the Principle of Relativity and the Quantum Theory, attracted a great deal of interest, and further enhanced the author's reputation as one of the most brilliant of our younger physicists. Another item on the programme was a paper by Dr. Milne, in which he gave his reasons for regarding Professor Eddington's and Sir James Jean's estimate of the temperatures of the interior of the sun and stars as much too low.

The discussion in the Chemistry Section on the present position of the British Dyestuff Industry appropriately took place immediately following the official issue by the Board of Trade of a review of the operation of the Dyestuffs (Import Regulation) Act which expires on 15th January, 1931, unless the Government decides otherwise. The discussion provided chemists, manufacturers and users of dyes with an opportunity of showing the commendable progress which has been made in dyes production in this country since 1914. A discussion on " Chemotherapy " in the same section also took place. This section provided the sensation of the week, the paper by Dr. M. Nierenstein on the " Pyryllium Series," in which he challenged the views of other chemists regarding the identity of pyryllium compounds derived from plants with the synthetic products, exciting a controversy and an exchange of courtesies more in keeping with a political meeting than a gathering of scientific experts.

In the Geology Section there was a discussion on the " Validity of the Permian as a System," a very technical subject but most interesting from the varied character and increasing volume of data which protagonists of different schools of thought have accumulated. Professor Abercrombie's opening contribution to the discussion in the Geography Section on " Satellite Towns " attracted much attention, as well as his and Dr. Vaughan Cornish's addresses on " National Parks " to the Conference of Delegates of Corresponding Societies, to which body also an appeal was made for help in establishing local Folk Museums as well as the proposed National Folk Museum in Regent's Park. The Economics Section rendered a distinct service by arranging a discussion on the " Value and Limitation of Costing in Industry and Agriculture," to which representatives of the Agriculture Section contributed and in which it was pointed out that an elaborate system of costing often defeats the object for which it was devised. And much that was valuable was said in the discussions in the Agriculture Section, among which was an address on the " Influence of Fertilizers on Yield and Composition of Plants."

Mr. Bernard Shaw Present.

Three other contributions call for special mention. The account of Mr. C. V. Dawe on the work in agricultural economics at Bristol University demonstrates that the willing co-operation of farmers in experiments and costing accounts benefits agriculture and science alike. Dr. J. F. Tocher's paper on the " Adulteration of Milk with Water " will cause public analysts some concern because Dr. Tocher's results are decidedly disturbing. Lastly, Sir Frederick Keeble's paper on " Agricultural Problems in South Africa " gave an account of experiments with fertilizers in different districts, and expressed his belief, by no means allowed to pass unchallenged, that mineral deficiencies in the soil rather than shortage of water are the cause of South Africa's pastoral troubles. To this paper the presence of Mr. George Bernard Shaw gave piquancy and brought to the Agriculture Section an audience which might otherwise have missed the opportunity of hearing one of the most interesting discussions of the whole meeting.

Exploring the Atmosphere by Air-waves.

By F. J. W. Whipple, M.A., Sc.D.

Superintendent of Kew Observatory.

The propagation of air-waves is now being studied as a means of discovering more about the upper atmosphere. The method consists in noting the times at which the waves produced by distant explosions are registered, and was the outcome of experience of the audibility of gunfire during the war There is much scope for experiment in this important branch of scientific research in all parts of the world.

THE experimental study of the propagation of airwaves to great distances began soon after the end of the war. As noted already in *Discovery**, it had been known since the days of Pepys that sounds were sometimes to be heard at very great distances from their origins whilst there was silence in the intervening regions. The first detailed examination of such phenomena was made by a German scientist, von dem Borne, who collected information about the audibility of a great explosion which occurred at Förde, in Westphalia, on 14th December, 1903. A dozen opportunities for such investigations followed, and in every case it was found that there had been an inner zone of audibility and one or more outer zones separated by regions where nothing had been heard.

An Early Theory.

Such a remarkable distribution of audibility called for explanation, and von dem Borne put forward the theory that the phenomena were due to the refraction of the airwaves after they had penetrated the atmosphere to an enormous height. He realized that to make the waves turn over and return to earth there must be a stratum of air in which the velocity of sound is very great. Accepting current views as to the constitution of the atmosphere, he attributed this great velocity to the high proportion of hydrogen in the air at heights of 90 kilometres or so above ground. According to this theory the track followed by the energy was horse-shoe shaped. The sound left the ground and returned to it almost vertically.

Von dem Borne's theory was not accepted by all investigators. Some thought that if only we had enough knowledge of the air currents at moderate heights it would be possible to demonstrate that the sounds had been brought down by wind. It was clear that to test this hypothesis it would be necessary for an explosion to occur at a time when very complete information about the upper winds was available. At the end of the war the time was ripe for experimental controlled explosions. The initiative was taken by Prof. A. de Quervain, a Swiss meteorologist, who had himself made several investigations of abnormal audibility. He had studied the audibility in Switzerland of the firing on the western front, and some years previously the audibility of an explosion which occurred when the Jungfrau railway was under construction. Unfortunately de Quervain did not live to discuss the results of the experiments made at his suggestion under the auspices of the International Meterological Committee. The first experimental explosion was at Oldebroek, in Holland, in October, 1922, and this was followed by a series of explosions at la Courtine, in Central France, in 1924. It was between the dates of the Oldebroek and la Courtine explosions that the clue was found to the explanation which is now generally accepted for abnormal audibility

The First Clue.

In a discussion of observations of shooting stars, Lindemann and Dobson came to the conclusion that the density of the atmosphere at the levels at which the luminosity is produced must be greater than current theory allowed. The explanation they gave was that the air below these levels must be very buoyant, that the buoyancy was due to high temperature, and that the high temperature was due to the selective absorption of solar radiation by ozone. As was pointed out soon after Lindemann and Dobson's paper appeared, the application of this theory to the problem of abnormal audibility was obvious. Whereas von dem Borne had suggested that the critical high velocity of sound was due to the excess of hydrogen in the atmosphere, the new explanation was that the high velocity was due to excessive temperature.

In studying the audibility of explosions which occur without warning we have no accurate knowledge of the time the sound takes to reach the observers.

* "The Problem of Abnormal Audibility," by C. Britton, M.Sc, April, 1928.

When an explosion is produced for experimental purposes, the time of passage of the sound from source to observer can be found accurately. This is of great assistance in interpreting the observations. The la Courtine observations proved favourable to the Lindemann and Dobson theory, but indicated that the transition from the low temperature of the atmosphere to the high temperature above was lower in the atmosphere than those authors had postulated.

German Research.

In Germany research on the subject has been carried on vigorously. The stimulus was given by Prof. Wiechert, the distinguished seismologist, and the first explosion was at Jüterbog on 3rd May, 1923. Two reports prepared by H. Hergesell and P. Duckert of the aeronautical observatory at Lindenberg include details of no less than 346 experiments carried out on seventy-one days, the latest on 26th March, 1929. To begin with, large quantities of explosive were used, and the observations were mainly by ear. Instruments suitable for recording the airwaves, whether audible or not, were soon developed, and came into use in increasing numbers. By 1928 twenty-nine instruments, mostly of the pattern invented by Prof. Kühl, and known as the undograph, were in use. These were distributed according to an ingenious system. They were placed approximately on a line passing from north-east to south-west through the place, Jüterbog, where the explosions were to be produced. It was realized, no doubt, that it was better to use the available apparatus to get observations which would serve to define the properties of a vertical section of the atmosphere, rather than to make an attempt at a broader picture.

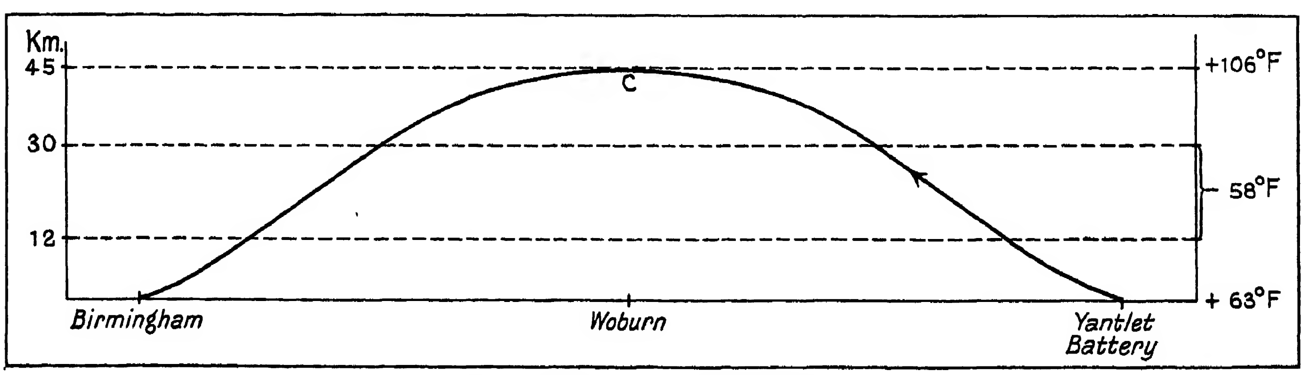
Of the three experiments made in this way, the first, that of 17th July, 1928, yielded good observations mostly to the south-west of the source of the waves. That of 19th December, 1928, yielded observations to the north-east. Waves from the third, on 26th March, 1929, were recorded in both directions. Records were obtained at Königsberg at the great distance of 578 Km.

In England we have been working on a more modest programme, but the results which have been obtained are of considerable interest. Attention has been concentrated on the airwaves produced by the discharge of guns. The waves have been recorded by hot-wire microphones. These instruments were developed during the war for "sound ranging," the location of hostile artillery. The apparatus has the advantage that the records from several microphones can be made on one strip of photographic paper. As an illustration, one of the records of the reception at Birmingham on 2nd August, 1928, is here reproduced. The objects of multiplying the records are to demonstrate that the waves are coming from the right direction, and to determine the angle of descent.

British Observations.

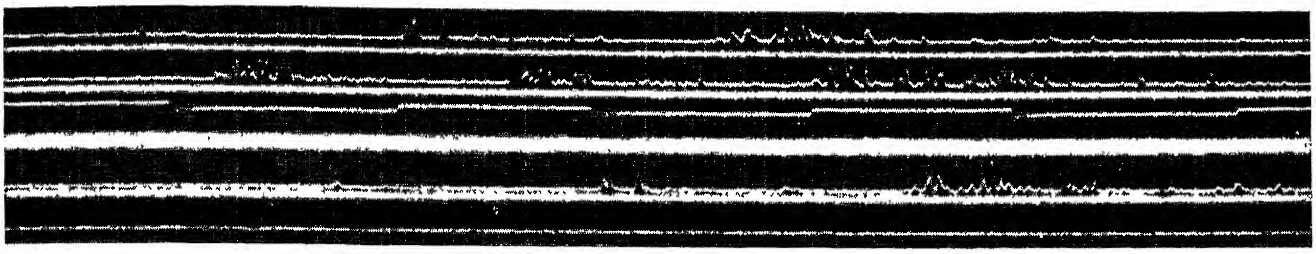
There are now microphones at six stations, Birmingham, Bristol, Cardiff, Exeter, Nottingham, and Sheffield. Up to the present the exposure at Exeter has not been satisfactory; the microphones are disturbed by traffic. Airwaves have been received at all the other stations, from Sho buryness, or from Yantlet on the other side of the mouth of the Thames, or from Woolwich. In obtaining the records we have had the co-operation, not only of the military authorities, but also of the British Broadcasting Corporation, by whose courtesy signals are broadcast from Daventry during the firing. The research is one which makes great demands on the patience and skill of observers, and I cannot let this opportunity pass without expressing my appreciation of the pains which have been taken at all the co-operating stations to secure reliable results.

All the successful observations have been made



THE ROUTE TAKEN BY THE AIR-WAVES.

The time taken by the waves to travel from the gun to the microphones is compared with the time which sound would take to travel along the ground. In this example the sound would have taken 615 seconds to travel the 210 Km. from Yantlet to Birmingham while the waves took 711 seconds, and were therefore delayed by 96 seconds.



AN ACTUAL RECORD OF AIR-WAVES.

One of the records of the reception of air-waves at Birmingham is here reproduced In England, attention has been concentrated on the air-waves produced by the discharge of guns, and the waves have been recorded by hot-wire microphones. The apparatus records from several microphones on one strip of photographic paper.

in the summer months. There have been trials in September and the winter half of the year, but no certain case of reception of the airwaves. The experience of war-time, when the firing on the western front was heard in England only in the summer months, has been paralleled

Registering Disturbances.

It should be noted, however, that although the apparatus was designed for "sound ranging" the disturbances which are registered need not be audible In fact, the observers have never reported any sounds which they could attribute to the firing. We know from the observations the time taken by the waves to travel from the gun to the microphones, and it is natural to compare this with the time which sound would take travelling along the ground. We calculate this time (neglecting the wind) and determine the interval by which the waves have been delayed For example, on 9th July, 1927, the temperature was 18°C., and sound would have taken 615 seconds to travel the 210 Km. from Yantlet to Birmingham. The waves took 711 seconds, and were therefore delayed by ninety-six seconds. In most cases the delay does not differ much from 100 seconds. It should be mentioned that in a trial lasting for an hour or two the times recorded are very consistent. The best examples of this consistency was on 17th July, 1928, when the times for eight rounds observed at Bristol agreed to a second.

The angles at which the airwaves descended have been determined on many occasions. Birmingham has been most successful. Angles exceeding 20° occur frequently. If we could detect the waves with our ears the sounds would seem to come from well up in the sky. On several occasions the records at Birmingham have shown a succession of separate waves. Generally it has been found that the first of these waves comes down at a small angle, and the last at a much larger angle. There was, however, one occasion, 11th July, 1929, when at the range of 174 Km. the first wave came down at 35° and the following wave eight seconds later at 22°.

Now let us turn to the object of these experiments—the exploration of the upper atmosphere. Consider in the first place the sort of trajectory described by the airwaves We ignore the influence of wind, and remember that in the lower atmosphere temperature falls off as we ascend so that the velocity of sound falls off also. In the stratosphere, which is entered at a height between 9 and 12 Kms., temperature may be taken as uniform. The passage of a wave through a medium in which the wave-velocity varies may be compared with that of a line of men marching over rough ground. When the men on the right flank march faster than those on the left the line wheels to the left, and the path travelled by one of the men curves to the left So when an elementary wave is passing through the lower atmosphere, the trajectory, or sound-ray as it may be called, curves upwards. In the stratosphere the wave goes right ahead, the sound-ray is straight. If the wave is to come to earth again there must be a region in which the velocity of sound is greater above than below. In the sketch shown the wave reaches the highest point at C, and then completes a symmetrical curve

A Simple Rule.

There is a simple rule which holds good with all such trajectories, *viz.*, the velocity of the wave at the top of the trajectory is equal to the final velocity of the wave along the ground. The only proviso is that the stratification of the atmosphere must be horizontal.

Now the velocity of the airwave along the ground is just what we measure when two microphones in action at the same station are in line with the source. For example, at Birmingham on 2nd August, 1928, waves originating at Yantlet came down at an angle of 16°. The apparent velocity of the waves along the ground was 355 metres per second. We deduce that at some height in the atmosphere this was the velocity of the airwaves. However, we cannot determine how much of the velocity was due to high temperature. The temperature corresponding with a velocity of 355 metres in still air is 106°F. If the air had a velocity

of twenty metres per second from south-east the relative wave velocity was only 335 metres per second and the temperature 45°F. To account for a return of the waves to earth entirely by wind whilst supposing the temperature to be that of the stratosphere (223°A. or – 58°F.), we should have to postulate a wind of no less than fifty-six metres per second.

The height which the waves reach before they return to earth cannot be estimated as readily as the velocity. We know, however, how fast the waves are travelling until they reach the stratosphere, how fast they are travelling at their highest point, and how long they take on the journey. We cannot go far wrong in estimating the height of the turning point. In this case of the waves which came down at Birmingham at 16° the turning point was about 45Km. above the ground. The waves which reached Birmingham on the same day with a very small angle of descent had turned at about 40Km., whilst the waves which came down at Bristol at 27½° had been to a height of 55Km. These results are typical.

Influence of the Wind.

Our English observations having been made only to the north and west of the origins of the airwaves, the question how large a part a wind plays in bringing the waves back to earth cannot be answered. It is likely, however, that there is between 40 and 55 Km. wind from some point between south and east during the summer months. The German observations lend considerable support to the hypothesis that there is a monsoon-like effect, the wind reversing in spring and autumn. With the stations mostly to the north-east and south-west of the explosions, airwaves have been recorded most frequently to the north-east in winter and to the south-west in summer. As a case of transition we note that on 26th March, 1929, there was good reception on both sides of Jüterbog and, moreover, that at places between 196 and 308 Km. the delay as compared with a standard of three seconds per kilometre was about the same (100 seconds) in both directions. Such symmetry implies that the wind in the higher atmosphere exerted little influence. The high velocity of the airwaves at the top of the trajectories must have been due to high temperature. It is reasonable to suppose that in other cases temperature is the most important factor.

The hypothesis of Lindemann and Dobson that the warmth of the atmosphere at great heights is due to the pressure of ozone has been closely investigated by Dr. E. H. Gowan. The quantity of ozone is exceedingly small (it would make a layer only 3 mm. thick if it could be collected and brought down to the ground) but Dr. Gowan finds that it would suffice to gather the thermal energy from the ultraviolet rays from the sun and warm up the air with which it is mixed. In recent years much attention has been devoted to the variations in the quantity of ozone in the atmosphere. It remains to be seen whether these variations can be correlated with the changes in temperature and in aircurrents revealed by the study of airwaves. There is scope for observation and experiment in all parts of the world.

New Light on the Origin of Man.

ARCHAEOLOGICAL discoveries in Africa throw interesting new light on the problem of man's place of origin. The illuminating suggestion that Kenya was nearer the place of origin than Europe was recently made by Mr. L. S. B. Leakey, leader of the East African Archaeological Expedition of 1926-9, in a lecture at the Merchant Venturers' Technical College. The development of the Stone Age cultures in Kenya, he said, was intimately bound up with the climatic changes, and a remarkable fact was that, with certain very important exceptions, the culture sequence in Kenya was identical with that in Europe. The earliest well-defined European culture was that known as chello-acteulean, and although Kenya was several thousand miles away from Europe the tools of this period were so similar to those of this culture in Europe that they could only be distinguished by their difference in material.

From the beginning of the second main pluvial period onwards there was clear evidence that in Kenya, unlike Europe, the Mousterian and Aurignacian cultures existed side by side, each developing along its own lines. The Kenya Mousterians appeared to be as primitive as their European cousins, but the Aurignacians, on the other hand, had a well-developed culture, and from their skeletons it was known that they were definitely ancestors of modern man.

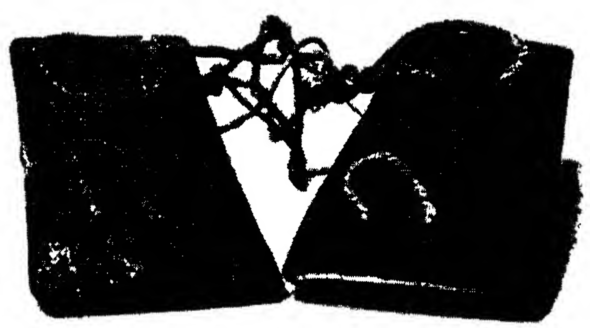
It was in connexion with this contemporaneity of the Aurignacian and Mousterian cultures in Kenya that the question of the exact correlation of the glacial periods of Europe and of the pluvial periods of equatorial Africa became so important. With the evidence as it stood at present, it looked as though the long interglacial period which separated the two pairs of glacial advances in Europe should be correlated with the long interpluvial which separated the two big main pluvial periods in Africa, and if this were correct correlation, the Aurignacian culture started very much earlier in Kenya than in Europe.

Across Bolivia.

By J. C. Bee-Mason.

As a member of a recent expedition, the author was able to explore the dense forests of the Bolivian wilds, and gives a first-hand account of the hazardous journey to the Andes. Untold mineral wealth lies dormant in the "chaco," and awaits the enterprise of the white man.

When Senor Mamerto Urriolagoitia, the Bolivian Consul-General in London, decided recently to organize an expedition across Bolivia, from the Paraguay River to the Andes, it was arranged that Julian Duguid, a graduate of Balliol College, should accompany him as chronologist, and I was engaged to make a film record. The first stage of our journey took us via Buenos Aires and the Parana and Paraguay Rivers to Lake Gaiba, near the Brazilian frontier. Here we were joined by Alexander Siemel, whose skill as a professional jaguar-hunter made him a welcome asset to the expedition. We were delayed for some weeks at Gaiba owing to the difficulty in obtaining horses and mules, but eventually we made a start with two horses, two mules and twelve oxen, and our provisions and baggage. Four natives were engaged to accompany us. We followed an Indian trail running almost due west in the direction of Santo Corazon.



TOBA FOOTWEAR !
Utility appears to be more important than comfort to the Toba, whose sandals consist of wooden boards, with ropes in which the ankle and toes are placed. This pair was worn by a savage captured in the Bolivian chaco

This part of South America was known to the ancient Incas, who named it *Chaco*, or hunting ground. The country is undulating, in places thickly wooded, in others prairie land, known locally as *Camp*. Here the native cattle have unlimited pastures, and cotton and tobacco plants grow wild. Our natives dried the leaves and made us cigarettes by rolling the tobacco in maize leaves. Near the Paraguay River the chaco abounds in wild duck, and the sportsman will find jaguar, wolf, fox, wild boar, deer, turkey, quail, partridges, and a host of smaller birds.

When three days from Lake Gaiba, Siemel spotted the tracks of a jaguar, and soon after a fine specimen fell to the gun of Senor Urriolagoitia. At Santo Corazon we remained for some days to rest our mules, and here exchanged the oxen for additional mules. We found our progress with the oxen far too slow, and wished to get through to Santa Cruz before the rainy season set in. This Indian village was established by Jesuit missionaries three or four hundred years ago. When they arrived the natives were naked savages, but the women were taught by the missionaries to wear long white overalls reaching to the ankles, and, although the Jesuits were expelled from Bolivia a hundred and fifty years ago, the women are still attired in long white overalls. Modesty, in fact, had been carried to such an extent that in a Jesuit temple we found a crucifix with the figure of Christ draped, also, in a garment reaching to the ankles. In this temple were many intricate carvings, and a prayer book from the private press of Balthasar Moreto of Antwerp, dated 1689. Duguid was anxious to possess the book, and suggested to Urriolagoitia that he ask the priest if he would part with it, provided that a sum of money were given to the church. The old Indian stood erect, and with great dignity said, "The church is not poor; we have six hundred head of cattle!" It was evident that any attempt to purloin the book would have ended disastrously for ourselves; it is certain that we should not have left the village alive. The natives here are known as the Chiquitanos Indians. They seemed unusually intelligent, doubtless as a result of the Jesuit occupation. The women were extremely industrious, and were busily engaged in weaving garments on looms, the cotton being spun by holding the spool between the toes.

We left Santo Corazon for San José, but instead of following the Indian trail we took a northerly course. This was the most difficult and strenuous part of the whole journey. For the next three hundred miles we cut our way through virgin forest, sometimes only progressing three miles in one day. In this part of Bolivia we were impressed by the wide variety of tree and shrub life, including quebracho, cedar, ebony, palm, acacia and mimosa; but we saw very few animals or birds. We had started at the close of the dry season; rivers were dried up, and the game had gone elsewhere in search of water. We had to search the river beds until we found soft mud in dense shade, fill our handkerchiefs with the green slime, and squeeze out what moisture was there to make tea, coffee, or soup. We were distressingly short of food, and only ate one meal of dried meat and rice every twenty-four hours: we maintained our strength by drinking Yerba maté, made from the leaves of a tree which grows wild in parts of South America The leaves, when dried in the sun, are placed in a seed pod, boiling water being poured over them. The tea is drunk through a *Bombilla*, or silver tube. Maté is now being cultivated extensively in Paraguay and exported to Europe, where it is sold as Paraguayan tea. It is very sustaining, and Indians are able to travel for days without food, drinking only maté. In the dry district we were troubled by a small bee, known locally as the "Sweat" bee. It has no sting, but clings to one's face, neck and wrists, absorbing the perspiration. At one place, they invaded our dinner plates in enormous numbers, and one night an army of red ants found their way into a tree where my hammock was slung and descended upon me, covering me with blisters the size of a penny.

THROUGH VIRGIN FOREST

The journey from Santo Corazon to San José was the most strenuous part of the whole expedition Instead of following the Indian trail a northerly course was taken, and a route had to be cut through three hundred miles of virgin forest

After many weeks we arrived at the Indian village of San José, where we remained for about ten days. We were still a hundred and eighty miles from Santa Cruz. The Indians warned us that the district beyond was swampy and abounding in insect pests. We had not proceeded very far when we reached the swamps, and for the greater part of the journey during the next ten days our animals trudged through the mud. The insects were extremely troublesome; huge mosquitoes stung through our riding breeches, and we and our animals were badly bitten by horseflies. We saw poisonous spiders six inches in diameter; they are able to jump six feet and feed upon small birds and mice. At night the air was filled with millions of tiny insects, almost invisible to the naked eye. They penetrated our mosquito nets at night so that sleep was impossible All through the night we walked up and down by the light of the moon, waving branches for protection.

After we had cleared the swamps, we discovered that we were being followed by about fifty Toba savages, a race which roams the forest in the southern part of the chaco. They followed us for many miles, and caused us considerable discomfort. At night, fearing an attack, we made a barricade with our baggage. Unknown to us, they poisoned our waterhole. Before leaving the next day, we went to fill our water bottles and found that they had stirred up the mud with branches which they had left lying about. We waited two hours for the water to settle before filling our bottles. A few hours later we were all taken seriously ill, with the exception of Duguid, who did not drink the water. We discovered later that the savages had poisoned the water by squeezing into it the juice of berries from which Croton oil is made. We were told afterwards that this is a well-known trick of theirs. On the following day, when a friendly Indian was struck on the head by a Toba arrow and seriously injured, Siemil shot one of the savages, and I brought home his sandles as a souvenir.

Ultimately we arrived at the Rio Grande, which had to be crossed before reaching Santa Cruz. The river is a tributary of the Mamore, which flows into the Amazon. All our baggage had to be unloaded and taken across the river in floats made of cowhide. The wagons were then taken over. This occupied the whole of one day. Three days later we arrived at Santa Cruz, and we then decided to pay off the natives who had come through with us from Lake Gaiba. As they were reluctant to pass through the

district occupied by the Toba savages, we gave the leader a rifle which he had learned to use.

It was our intention to proceed from Santa Cruz to Sucre, the legal capital of Bolivia, but the natives warned us that the route was dangerous owing to abnormal rains. We therefore decided to turn south through the forest, down to the Argentine frontier. An American contractor had been cutting a road through a part of the forest for the Bolivian Government, and he kindly lent us a motor lorry. We hoped to make a journey of two hundred miles in three days, but it rained every day and the journey actually occupied nineteen days. Time after time the car sank axle deep in the mud. We had to unload, jack the car out of the mud, strew branches on the ground over which we pushed the car on to firmer ground, then carry our baggage through the mud and rain to reload. This occurred on an average every three miles. When we had pushed the car for nearly eighty miles we decided to abandon it, and left it in the middle of a river continuing the journey on mules.

THE TEMPLE AT SAN JOSÉ.
The seventeenth century Jesuit temple was the centre of an early campaign of rigid reforms. The temple still prospers, although the Jesuits have long been expelled

Before reaching the Argentine frontier we crossed the Parapiti, or " River of Death," the most dangerous in the whole of South America. Frequently the water suddenly rises at least ten feet without any warning, owing to storms in the mountains perhaps a hundred miles away. We had to undress, tie our clothes on our heads and swim across, the natives taking our baggage. I swam across first, while two picked Indians carried my camera and tripod. Senor Urriolagoitia followed. Before Duguid and Siemil could cross a wall of water six feet high came down and the river was soon a raging torrent. It was four days before our friends could rejoin us.

Two weeks later we arrived at Yacuiba, on the Argentine frontier, having penetrated eight hundred and fifty miles of forest. From Yacuiba the journey took us through picturesque country, dotted with farmsteads. Instead of forests and swamps, we now traversed rolling pastoral country, ideal for cattle raising. We turned eastward to Tarija, a town with a population of ten thousand, and situated six thousand feet above sea level. Near the town several perfect skeletons of the masterdon have been found We saw a portion of one skeleton near the river, and I secured a part of the jaw with four perfect teeth and also a piece of tusk. About sixteen miles north of Sucre, a landslide had occurred just before our arrival, disclosing a burial ground of the Incas. I obtained a small earthenware vase in perfect condition.

Sucre is a delightful city with a perfect climate. The heat is never oppressive, frosts are unknown, and being over eight thousand feet above sea level there are few insects. At Potosi we saw the famous silver mountain, from which £7,000,000 worth of silver has been extracted since 1545. We visited the famous Aramayo silver mines at Atocha, and the Patino tin mines near Oruro, from which over fifty thousand tons of tin is exported annually. We began to realize how rich in mineral wealth Bolivia is when we learned that she has in profusion tin, silver, nickel, antimony, copper, gold, zinc, bismuth, borax and oil.

In the past, emigrants flocked to the mountains in search of minerals, while the enormous resources in the forest were ignored. The Government now recognizes that untold wealth lies dormant in the " chaco." Where experiments have been made the finest coffee has been grown. The native cotton grows to a height of six feet and produces six to eight pounds of lint. Since the discovery of the valuable tanning properties which the quebracho wood contains, the value of this tree has increased enormously. During one part of our journey we passed through one of the largest quebracho forests in the world. For a hundred and twenty miles eighty per cent of the trees were quebracho. In the Gran Chaco seepages bear evidence of the presence of oil.

There is no doubt that insect pests have discouraged the white man, but what has been accomplished in other parts of the world can be repeated in the Bolivian chaco. Years ago, notices were exhibited at all British ports warning sailors against signing on for any ship sailing for Santos in Brazil, but to-day Santos is a health resort.

Migration of Elephants.

By Cyril Hopwood.

Formerly of the Imperial Forest Service.

A curious characteristic of the Lower Burmese elephant is that, unlike the species found elsewhere, it has developed definite migratory habits. The author, who was for two years in charge of the South Tenasserim Forest Division, has made a close study of the animal, and here reveals the reasons for this abnormal trait.

ALTHOUGH Indian elephants roam in herds over a considerable area, and change their feeding grounds as may become necessary to ensure a sufficiency of fodder and water, they are not considered as being migratory animals in the usually accepted sense of the term. But where the frontier of Siam meets that of South Tenasserim, in Lower Burma, the elephants have developed very definite migratory habits.

IN SEARCH OF SALT.

At the beginning of October the herds break up, and the elephants make their way in small parties to the sea coast Local opinion emphatically holds that the animals come there in search of salt, and the author thinks that this view is probably correct

The animals which inhabit this area are a distinctly small race of the Asiatic elephant, the males rarely exceeding eight feet at the shoulder, and the females averaging about six feet, but mature animals of even smaller size are by no means uncommon. Further, the tusks of the males are never large, and many males are tuskless; *Hines*, as they are called locally. Although the possible connexion of small size with migratory habits has not been established, the point is of interest as showing a tendency to variation from the normal, and may indicate a step in evolution, though scientifically there is no distinction between the Siam-Tenasserim animal and the typical Asiatic elephant, all being referred to the single species *E. Maximus.*

Elephant catching is extensively practised in South Tenasserim, under licence from the Government of Burma, and as elephants are of great value to the Forest Department and the timber firms, they are rigorously protected. During the two years that I was in charge of the South Tenasserim Forest Division, I was called upon to advise the Government concerning the conditions under which licences were to be issued, and this work naturally entailed a close study of the habits of the animals. Personal observation combined with questioning of the native elephant catchers, some of whom were most intelligent men with a wealth of experience in this highly specialized art, elicited the fact that the elephants are only gregarious while living in the Siamese forests, east of the border, roughly during the months of April to September. I am not saying that no elephants will be found west of the boundary, that is, in Tenasserim, during this period, but they are far from numerous, though conditions of food and water would appear to be quite suitable.

About the beginning of October, the herds break up, and the elephants make their way singly or in small parties, rarely exceeding six or seven individuals, by well-known and clearly defined routes over the border. Their objective is the sea coast, and local opinion is emphatic in stating that they come there to eat salt. Probably this view is correct, for elephants in common with deer and other animals patronize the jungle salt licks in other parts of Burma remote from the coast, and although I have never seen elephants, or their spoor, actually on the beach, they certainly do come as far as the landward side of the mangrove swamps, and would have no difficulty in obtaining as much salt as they require from the brackish creeks that run from the coast for many miles into the forest.

Be this as it may, they certainly prefer the low-lying forest country, within a few miles of the sea, from October to March, and during this period they never form herds, though a few individuals may be found in company. A cow, with a calf at foot, is always solitary at this period of the year, as are the males. The small parties met with consist of young cows and calves of two to about five years of age. As soon as the hot weather commences, the return migration takes place, the beasts again travelling singly or in small parties, and only forming herds some time after they have reached Siamese territory. The habits of these elephants, and the now fully ascertained period of gestation of twenty-seven months, indicate that pairing takes place during the gregarious period, as newly-dropped calves are most commonly met with in October, which would place the actual mating date in July, that is, well after the herds had had time to re-form.

The methods employed to capture the elephants are peculiar, and have little in common with the keddah operations practised in India. Advantage is taken of the migratory habit, in fact, success depends upon an intimate knowledge of this. The trap, a miniature keddah constructed of stout saplings bound with cane, is placed upon a well-frequented route, and most carefully camouflaged. There is no driving beyond a very slight tapping with sticks far behind the elephants to keep them on the move, the object being for the intended victim to wander into the trap as it slowly follows the track ; the traps themselves are designed to hold only a small number of animals. When one or more have entered the trap, they are secured by dropping a kind of portcullis, which has been suspended over the entrance by a cane. This is severed by a man stationed high up in a tree, allowing the gate to fall into position and to secure the captives. When more than one elephant is in the trap, it is for the operator to decide upon the ideal moment to drop the gate.

If cupidity gets the better of discretion, and too many are allowed inside, the chances are that the sheer weight of the terrified beasts will break the sides of the trap, and the reward of weeks of patient waiting will be lost. A bull elephant is on the average worth about three cows, and should a bull be the first to enter, the gate is dropped at once. Alternatively, if two or three cows enter and a bull is following, the gate is dropped so as to exclude him, as it is usually he that succeeds in breaking the wall of the trap unless captured singly.

I understand that in Africa it is a common practice to shoot young bulls to prevent them from leading cows out of the reserves. I do not think that this indicates a migratory instinct in the African species, but that it is merely the desire of a young bull to obtain lordship of a herd. The same tendency is found in the Asiatic elephant, and if the young bull is successful in forming a harem, but is not sufficiently powerful to defeat the existing lord of the herd, it is obvious that he must change his territory. In such cases as this the impulse would appear to be due to sexual rather than migratory instincts.

[*Indian Railways Bureau.*

THE CAPTURE OF A YOUNG BULL.

Elephant catching is extensively practiced in South Tenasserim and, as the beasts are of great value to the Forest Division and the timber firms, they are rigorously protected The methods employed have little in common with the keddah operations practiced in India, but success in trapping depends upon an intimate knowledge of the migratory habit.

The "Life Layer of the World."

The study of the soil is a comparatively new but rapidly developing branch of geology. In an article in the American "Journal of Chemical Education," of which the following is a summary, Dr. R. R. McKibbin, of MacDonald College, Quebec, discusses the main groups of soil constituents, explains the effect of the climate on soil structure, and outlines the methods of classification adopted in America and Russia.

THE only place where life of any kind can continue to exist on the earth is in a junction layer between what are known as the lithosphere, the hydrosphere, and the atmosphere. In the lithosphere there occur both water and gases, in the hydrosphere there are both solids and gases in solution, and in the atmosphere there are much water vapour and much finely divided solid matter. Wherever life occurs we find solids, water, and gas. Nearly all the land animal life, and practically all of the land plant life except the tops of trees, are in a state of nature concentrated in a soil and lower air layer of the world less than twenty feet thick. Some micro-organisms and many of the seeds of plants may survive for a long time in the atmosphere or deeper in the lithosphere, but they must eventually return to what may be termed the "life layer" of the world. It is as "the life layer" that I wish to define the thin outer soil layer of the land areas of earth.

Systematic Classification.

Soil science is quite young. It is an offspring of geology. The first essential thing that must be done by any science in its own field is classification. The systematic classification of their soils is well advanced in many countries. The two leading countries of the world in this respect are the United States of America and Russia. In the United States, the classification of soils has chiefly been carried out by the Federal government working through the Department of Agriculture, and about fifty per cent. of the land area of the States has been classified into different soil provinces (or regions), series, and types.

The United States system of soil classification has been developed to take into account variations in the geological origin of the mineral portion of soils, climatic effect on soils, plant ecological variations, and many other factors which the skilled soil surveyor recognizes with ease in the field. Profiles (exposed sections cut down through soil and subsoil) of uncultivated land are examined and the number and thickness of the different layers in the soil are noted. Chemical determinations are made on each of the layers (termed "horizons" by the soil surveyors). The colour and texture of each horizon are examined. Areas having soils essentially alike are grouped together and an identifying name is given to the whole. Thus, "Sassafras silt loam" and "Leonardtown silt loam" are different areas of soil occurring in the Atlantic Coastal Plain province, of Sassafras and Leonardtown series, respectively, and both of silt loam type. There are important chemical and physical differences between these two kinds of soil which are reflected in the nature of the crops best adapted to each, in their relative need of specific fertilizers and in their natural mechanical condition.

Preparing Maps.

The final result of the soil survey of a given unit of area (generally a county) is the publication of a description of the soils occurring within the area. The most valuable part of the published results of a soil survey is the map, generally having a scale of one inch to a mile, which portrays the extent of the different soils encountered. These maps are invaluable to anyone who wishes to know the nature of the soil at any given point. Such soil maps are generally obtainable from state agricultural experiment stations. Primarily, the United States soil surveys have been designed to be of value to farmers and to those who are helping to disseminate information to farmers.

It is claimed by some that the Russians have "put the bones and sinews" into soil science. At any rate, there has emerged from that vast land a system of soil classification that is applicable the world over. For many years the collection of taxes from the peasants in Russia has been based upon information gained from soil classification. The government has, perhaps, been more interested in soil classification than the people have. The Second International Congress of Soil Science was held in Leningrad last July, while the first was held in Washington in June, 1927. In both cases, the convention of scientists was followed by a trip throughout the country in which it was held to enable the visitors to study the soils. The Russian conception of the differentiation of soils

is that they owe their chief characteristics to the nature of the climate. "Necessarily," they say, "the soils of cold climates must differ greatly from those of hot regions, and those of humid climates from soils of arid areas." By means of the system of classification that the Russians have developed, one can confidently predict the general nature of soils that will normally be encountered in any part of the world.

Soil Constituents.

There are four main groups of soil constituents. Upon the dominance of one or more of these groups of constituents depends the character of a soil The nature of the climate in which the soil occurs will very largely determine which of the groups of constituents will be dominant and the condition in which these constituents will be present. The groups are: The sesquioxides of iron and aluminium, silica; the strong bases (calcium etc.); and organic carbon compounds. Let us in imagination start at the poles of the earth and work toward the equator. Beneath the polar ice sheets we do not expect to find true soils. Life in the Arctic and Antarctic polar regions is confined to the sea and to adjacent ice-clad shores. Advancing a little farther from the poles toward the equator we reach the land of the tundras, where, in summer, some inches of the surface soil may thaw out and where lichens, mosses, and a few flowering plant species exist. Some of the southernmost islands between South America or Tasmania and the South Pole, and vast stretches of northern Siberia and of northern Canada, are typical tundra regions. One hesitates to apply the name of soil to the outer layer of the crust of the earth in these regions, but at any rate it supports life and will answer to the general definition given for soils.

The next main "belt of soils" below the tundras is termed by the Russians "podzol." These soils are sometimes called "grey earths" or "forest soils." They are relatively high in silica, low in the strong bases, low in iron and aluminium, and until the final stages of leaching (or podzolization) they are quite high in semi-decomposed organic matter, which is well described by the Germans as "roh humus." These podzols occur in cool, humid climates and are generally open-textured, sandy, or gravelly soils, deficient in strong bases. They present a tri-coloured appearance.

Under Quebec conditions, the top layer (roh humus layer) is mostly semi-decomposed carbonaceous material very black in colour and of varying depth. Below the black layer appears a bleached and leached "ashes colour" layer, also of varying depth. Organic acids from the "roh humus" layer are effective solvents of soil minerals. Below this is a layer of rusty red colour, in which some of the sesquioxides leached from above have accumulated. Concretions of iron and aluminium oxides with organic matter are often present in this layer. Below the reddish layer will be found sand and gravel usually to a depth of many feet. On the North American continent the podzol belt includes a large part of the New England States, most of the south half of Quebec (although there are many "glacial till" clays of excellent fertility), northern Ontario, and there are podzol-like soils in the northern parts of the western Canadian provinces. In South America, the southern half of Argentina (part of Patagonia and Tierra del Fuego) has many podzols. Nearly one hundred years ago Charles Darwin, one of the greatest observers the human race has had, remarked the great accumulation of semi-decomposed organic matter in many of the forests of Tierra del Fuego and the light colouration of some Patagonian soils. The podzol belt soils are generally very acid. On some of the most advanced podzol soils, organic matter has almost disappeared and silica is the dominant soil constituent. Within the podzol soil belt there may occur limestone soils and other soils that are well supplied with minerals, but these are exceptional.

"Earth Belts."

It must be understood that these vast "earth belts" of soils are very irregular in width, and that they are mixed up with each other. In the last paragraph the presence of relatively great amounts of silica and of organic matter in the soils of moist, cold climates was emphasized Under water-logged conditions such as those met with in swamps and bogs, organic matter accumulates almost to the exclusion of the other main groups of soil-forming constituents. Throughout eastern, central, and northern Canada and in the northern United States there are many millions of acres of peat bogs, in which organic matter is distinctly dominant.

Semi-arid and arid climates have a great effect on soil conditions, whether their soils occur in hot or in cold regions. Under conditions of little rainfall the strong bases tend to accumulate. Evaporation of water from the soil exceeds rainfall, so there is little leaching. Under some arid conditions both alkali metals and alkaline earths tend to accumulate. The Russians name those arid climate soils containing alkali carbonates, "Solonetz," and others which contain neutral salts, "Solonschak."

Certain semi-arid conditions, exemplified in the great spring wheat-growing districts of the western United States and Canada, are such that organic matter can accumulate in the soils to a considerable extent. In warmer climate, semi-arid regions, and where there is more even distribution of rainfall throughout the summer, the lack of organic matter in the soils is perhaps their greatest deficiency The black, high organic matter soils, rich in strong bases and particularly rich in calcium, are named " Tschernozem " by the Russians. These soils, found in the wheat-growing areas of Russia as well as in western America, are probably the most fertile soils in the world, although corn belt farmers, whose land lies on the eastern fringe of the North American tschernozem area, may have the right to protest at this statement.

Effect of Arid Climate.

As a general rule it may be said that semi-arid and arid climate soils have a relatively high percentage of strong bases and are deficient in organic matter. Silica and the sesquioxides fall into the background slightly in these soils, although they are usually relatively more soluble in strongly alkaline soils of arid climates than they are in cool, humid climate soils. Intelligent application of water to arid soils results ordinarily in making possible the growing of tremendous crops. It is a striking historical fact that the most ancient civilizations were erected on arid soils. Egypt, obtaining her irrigation water from the Nile, lay on the edge of the Libyan desert. Babylon and Chaldea, Assyria, Phoenicia, and Judea all were arid climate or semi-arid climate civilizations. The fertility of desert soils, when they are given water by those who know how to apply it, is phenomenal. The important part played in soil fertility by the strong bases of the soil is at once apparent from this statement.

Farther down toward the equator than the podzol, glacial clay, and tschernozem areas, the " brown earth " soils are to be found in humid climate regions. In the United States, from Virginia southward, the soils acquire more and more of a reddish colour. This is because of their gradually increasing content of iron.

South temperate, sub-tropical, and tropical soils, under moist conditions, generally are high in iron and aluminium and (except in water-logged areas such as the Florida everglades) they usually contain less organic matter than those of colder climates. There is relatively much less silica in warm climate soils than in northern ones. Iron accumulates in these soils and so also does aluminium. The bauxite deposits of Demerara arise from this primary cause. These red-coloured warm-climate soils, which form under conditions of ample moisture supply, are called " laterites " and the process of their formation is known as " lateritization." True lateritic soils are usually ill-supplied with strong bases. In Cuba the United States, soil survey workers have studied the laterite type of soils. Bennett describes them very clearly.

The fact has been emphasized that organic matter tends to accumulate in cold humid-climate soils and tends to disappear from warm, non-swampy, humid-climate soils. This may be taken as an index of the potential " life energy " within the two kinds of soil. Tropical soils produce luxuriant jungle vegetation ; this dies and becomes soil organic matter. The processes of delay are so speedy in tropical soils that organic matter quickly " fades away," due to micro-organic action, in the form of such end-products of decay as carbon dioxide and nitrate nitrogen. The carbon dioxide concentration in jungle air consequently is very high, and the nitrate nitrogen leaches away in soil drainage water in relatively great quantity.

Tropical Soils.

While in podzols and brown earths the accumulated semi-decomposed organic matter is a source of organic acids, which profoundly modify soil conditions by their action, in ordinary well-drained moist-climate tropical soils the processes of decay are so rapid that organic matter quickly rots, producing carbon dioxide and the silica tends to leach away.

Over a very extensive zone on either side of the equator there is normally a region of very great rainfall. Next there is a band of regions of less humidity, and then a girdle of arid lands which varies much in width from north to south, and which extends right around the world. High mountain ranges and the direction of ocean currents have much to do with the extent of aridity in these lands. In the southern hemisphere the west coast of South America is arid, in Australia a great portion of the island-continent is desert land, and in South Africa the Kalahari desert exists, surrounded by semi-arid lands. In the northern hemisphere, with its greater land masses, the west central part of North America is arid or semi-arid ; in Asia the desert of Gobi, the arid regions north of Tibet and Afghanistan, and the peninsula of Arabia lie in this band ; in Europe the tip of Spain ; in Africa the enormous extent of the Sahara desert and the aridity of Somaliland testify to the continuation of the " dry belt."

Book Reviews.

New Frontiers of Physics. By PAUL R HEYL, Ph D (Appleton. 6s).

There have been many books of late years describing the progress and meaning of science in non-technical language This is yet another, but an excellent one It has the great merit of being thoroughly up to date The author cannot be said to shrink from any difficulties in his task, and, indeed, there are many, he acquits himself every time with gratifying success It is by no means an easy matter to retain accuracy of expression when explaining the principles of Schrodinger's wave mechanics for the benefit of the untrained reader, and the same may be said of relativity and the quantum theory The simplicity with which attractive diagrams could be drawn of the Bohr atom probably accounts for the sudden access of popular interest in atomic physics There appears to have been something quaintly piquant in discussing the ubiquity of those little planetary systems which, although of profoundly highbrow significance, lent themselves with such ready urbanity to dinner-table small talk The unrelenting sternness of Newtonian physics had no such popular appeal, and it may be that, with the advent of a new conception of the atom, which admits of very little picturesque treatment, there will be less demand for graphic dissertations

Popular interest in science, although gratifying, is not without danger There is the possibility that the scientists' analogies may be interpreted too literally That certain phenomena behave *as if* there were tiny planets in atoms and that light sometimes behaves *as if* it were composed of little darts may lead to the erroneous notion that these graphic images are indeed tangible facts. The borderline of physics and speculative philosophy is becoming less and less defined Physics is becoming more and more a mesh of mathematical conceptions We must be careful not to convey to the laymen the idea that a new atom, for example, has been found, but rather that a new and wider mathematical treatment has become necessary in order to equate experimental experience. The book under review is good because it emphasizes this point of view, and it is interesting in as much as it describes experimental data and relates it to the development of theory. The book fully justifies its title and is confidently recommended.

V E PULLIN

The Study of Crystals By D. B. BRIGGS (Dent. 4s)

The Atom. By G. P. THOMSON. (Thornton Butterworth 2s. 6d.).

The study of crystals has of late years become one of the most important of all branches of scientific investigation. It is a matter pertaining to physics but, like many other branches of that subject, it is of fundamental significance in the progress of the sister sciences. Investigation of crystal structure by X-rays has confirmed one of the most important theories of organic chemistry—the existence of the benzene ring, and it has also enabled the atomic arrangement in complicated molecules to be determined beyond any doubt. Engineering materials depend for their all-important physical properties upon the structure of their constituent crystals and its progressive modification. More and more, therefore, do engineers depend upon the crystal analyst to tell them about the effect of stresses upon these tiny units. Crystal structure is nature's method of preserving symmetry and regularity in her building operations. Almost all solids are crystalline; in fact, those which appear not to be probably suffer merely from under-development Before 1912, crystallographers had to be content with the study of the external form of crystals and the measurement of the angles between the numerous facets, but thanks to the discovery of X-rays and the mathematical insight of Professor von Lane, it has now become possible to examine their internal structure and to marvel at the beauty and symmetry of the delicate atom lattice work which confers on the crystal its characteristic external form

Mr Briggs has written an admirable little book It is compact and contains no irrelevant matter He describes various types of crystals and tells of the methods which are used in examining and classifying the conventional groupings. He explains the growth of crystals and the factors which operate to differentiate their form. Two chapters are devoted to the study of crystal structure by X-rays, and it is a pity that more space was not given to this important aspect of the subject, but this small criticism must not be allowed to weigh against the merit of the book as a whole It is a book for the amateur no less than for the scientist In particular, the worker in X-ray crystal analysis will welcome it as a handy and concise work of reference.

The second book is a very readable and general account of atomic structure and its significance in general chemical and physical theory Professor Thomson is a reliable authority on the subject, and writes in a most interesting manner His description of the new wave theory of matter is clear and straightforward The book is a valuable addition to this excellent library

V. E P

With the "Italia" to the North Pole By UMBERTO NOBILE. Translated by FRANK FLEETWOOD (Allen and Unwin 15s)

The interest in this book lies not only in the graphic account which it contains of the ill-fated expedition to the North Pole, but because it provides General Nobile's own explanation for the fact that he allowed himself to be rescued before his crew The book is also valuable as affording a keen insight into the personal character of the explorer, of his gallant endurance of hardship and adversity; and many who were inclined to suspect his courage will doubtless wish, on reading the book, to accept the explanation which is offered. The report of the Inquiry Committee, held in Italy under the auspices of the Admiralty, is criticized in a preface It is suggested that the Commission was handicapped in its judgment by invoking the testimony of a pilot officer, who some years before had been imprisoned for calumnies against General Nobile, and that of a technician who had been the explorer's competitor in airship construction and had motives for personal enmity.

An interesting account of the programme of scientific investigation is given. The oceanographical researches were of primary importance It was first of all necessary to discover whether it was possible to carry out research from the airship without disembarking anyone It was also necessary, of course, to reduce the weight of the apparatus to a minimum, as it was impossible to adopt instruments as heavy as those used at sea. The two fundamental problems to be solved were the sounding of the sea, and the collection of samples of sea water and the

measurement of its temperature at the same time. Nansen, with whom the author discussed the subject, assured him that even a single sounding, taken in the middle of the Arctic Ocean towards Siberia and Alaska, would be of inestimable value Nobile concentrated his attention upon wire and acoustic soundings. For the wire soundings a satisfactory device was eventually discovered It was a small rubber float, like a circular air cushion, on which was fixed a reel of thin steel wire, unwound by a pointed lead weight of about eight kilos, tied to the free end As soon as the dirigible had anchored, this apparatus was lowered into the sea with a cord. By means of a very simple control, worked from the pilot cabin, the weight was then released, so that it could descend freely, dragging the wire after it The length of the wire unwound when the weight touched the bottom and measured the depth There were many small difficulties to be overcome, but at last the experiments made in the air and from the water itself gave satisfactory results.

The question of taking samples of sea water at different depths, and measuring their temperature, was equally long a difficulty to solve The collector eventually chosen for use consisted of a cylindrical tube with a valve at each end which, when the apparatus was overturned, shut itself hermetically, enclosing the water that filled the tube When the experimenter saw that the collector, which was fastened to the end of a soundingline, had reached the required depth, he himself reversed it, by dropping a little piece of metal like a blunt cone This weight, as it slid down the wire, struck against the collector, which was overturned by the blow A reversing thermometer was attached to the collector.

Research in terrestial magnetism was divided into two parts · magnetic measurements made during the flight, and measurements to be taken if a descent was made on the ice. The first problem was bristling with difficulties. To start with, it was necessary to find a means of determining the influence which the magnetism of the dirigible itself exercised upon the magnometers. Then a doubt arose as to whether the rapid vibrations produced by the engines, and sometimes also by the wind, would permit successful measurements at all. Eventually a compass was adopted which had already been tested on board ship during the German South Polar Expedition of 1901. The only difficulty to be overcome in connexion with making observations on the ice was that of finding a method sufficiently rapid, since it might be imprudent to remain on the pack for more than three or four hours. A dip circle was borrowed from the Carnegie Institution of Washington which seemed peculiarly adapted to the conditions under which observations were to have been made.

Research in atmospheric electricity and radioactivity appear to have been the most complete of the investigations attempted.

The Selenium Cell By G. P. Barnard. (Constable. 35*s*)

There are several new scientific developments which depend for their success entirely on the effect of light upon the electrical properties of a cell. The most important, of course, is television and its associated phenomena, and talking films. There are two alternative courses open to the experimenter He may use either a material like selenium which, when irradiated by light, changes its electrical resistance, and thus may be used to record variations in the intensity of the illuminant, or he may use what is known as a photo-electric cell, of which several different patterns are available commercially. In some cases, for example, talking films and television, the selenium cell has probably certain advantages. This curious property of selenium was discovered in 1873 Since then it has been used and studied in diverse ways by many observers, so that the resulting literature on the subject is profuse and scattered.

Mr. Barnard deserves the thanks of all scientific workers for this excellent compilation of knowledge concerning selenium Much that he describes is his own work, but he has certainly omitted nothing of any value that has been done by others. It will become the standard work of reference on the subject The book is divided into two parts, the first being devoted to the properties of the element, together with an account of the theories of the action of light on selenium and a description of the construction of the various forms of cell. The second part is concerned with the numerous applications of selenium, both historical and present day A remarkably complete bibliography is provided at the end of each chapter There are valuable appendices in which are tabulated all the physical, chemical, electrical and optical constants of selenium and a list of the tests appropriate to the cells. Incidentally, in the second part of the book, the author describes in a very full and interesting manner the various methods and systems employed in television, talking films, light telephony and so on. This section of the book will therefore be found of considerable popular interest. The whole constitutes a valuable work of instruction and reference for the scientific man. The diagrams are profuse and excellent and the printing and arrangement of the book is good

V E P.

The Living Past By John C Merriam. (Scribners. 7*s* 6*d*).

In the region known as Rancho La Brea, in California, there is an extensive swamp of asphalt which has poured from the ground in springs for thousands of years Investigations have revealed the fact that the swamp contains the remains of prehistoric animals, as was described in a recent article in *Discovery*. The creatures had ventured on to the asphalt and had been engulfed. Their discovery has led to extended scientific investigations, involving excavation of the asphalt pools and reassembling of the skeletons unearthed A vast amount of material has been brought to light which has been estimated at approximately three million bones. Not only is the material perfectly conserved, but there is interesting evidence of the mode of life of the animals represented

These investigations are among several episodes in archaeological research described in this diverting little book by Mr. Merriam, who is President of the Carnegie Institution, Washington. Geological and anthropological discoveries which he has conducted are reviewed, and their significance in what he terms the history of life is explained Other chapters are entitled "The Meaning of a Fragment," "The Story of a Leaf," "An Abyss in Time," and "Footprints on the Path of History." One of the early excavations at Rancho La Brea revealed the skull of an ancient tiger

In the great number of beasts entombed in the asphalt lake, a large percentage are of types no longer living in any part of the earth. Many of these have their nearest relatives in the life of still earlier ages; such are the sabre-tooth, mastodon, ground sloth and many others. The elephant, camel, and horse have, of course, close relatives living to-day in other continents. With these two groups are other species, such as the coyote and puma, the rodents and many birds and plants which intimately resemble animals to be found in California to-day.

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Editorial Notes.

Thomas Edison has long been regarded by the American public as their Grand Old Man of science, and his life has just been written by Mr. Henry Ford. His little book is entitled "My Friend Mr. Edison," and it gives the story of a friendship that began over thirty years ago. The inventor was the first employer of the now famous motor manufacturer, and from their first meeting the younger man developed a strong admiration. Mr. Ford recently had the satisfaction of acquiring the laboratory where Edison developed the incandescent lamp and of adding it to his museum at Dearborn. For this purpose the building was moved more than a thousand miles, and it now stands as a permanent memorial to Edison's early discoveries. Mr. Ford explains that the work of Edison falls into two great divisions. The first has to do with his direct contribution of inventions—tools. The second has to do with his example in linking science with everyday life and demonstrating that through patient, unremitting research any practical problem may be solved. "It is probably impossible," the biographer adds, "to determine whether his actual accomplishments or the force of his example have been the more valuable to us." The scientists of the old school have never considered Edison as one of themselves because he has been more interested in practical applications than in pure research. In the same way the engineers have not regarded him as an engineer because he worked on untraditional lines. In fact, however, Edison did much to establish the modern spirit in both science and engineering, which is to say that research and its practical applications are essential the one to the other. Mr. Ford emphasizes this achievement in his most readable volume, which reveals much in common between the minds of a great inventor and a great engineer.

* * * * *

Not since 1912, when the *Titanic* went down in mid-Atlantic, has any disaster aroused such world-wide sympathy and interest as the deplorable loss of the new airship R. 101, with forty-eight lives. Whether its crashing against a hill was due to some sudden barometric change throwing the altimeters out of action, or whether the general construction was at fault, are questions for the investigating experts. Adverse opinions on the future of the airship have already appeared in certain quarters, but it would be a poor tribute on the sacrifice that has been made to regard the disaster as the final judgment on this form of flying. Any attempt to explain away its lessons must equally be avoided. One question can be discussed without delay, and that is whether helium gas ought not to be used in all future airships. It was hoped that the oil engines fitted to R. 101 would eliminate the risk of fire attaching to hydrogen, but this did not prove to be the case.

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At present the European sources of helium are negligible for airship purposes, so that it would have to be imported. In the United States a determined search for the gas, and an equally determined effort to purify it cheaply, have been so successful that the supply is now sufficient for military balloons and airships. This gas in very impure form occurs with Natural Gas, and as much as a million cubic feet a day exudes in certain parts of America, particularly in Texas. The cost of purifying it is now about 38s. per thousand cubic feet, *i.e.*, from five to nine times the cost of a thousand cubic feet of hydrogen. It is likely that further research will reduce this ratio in

the future. The gas is found in smaller volume in Canada. Helium is the only alternative to hydrogen known to science, and although it is twice as dense as hydrogen it has more than ninety per cent of its lifting-power. It is quite safe, and it cannot burn or explode.

* * * * *

Wing-Commander Kingsford Smith's record flight to Australia in a single-engined machine is noteworthy not only as a remarkable feat of physical endurance, but as an eloquent tribute to modern aircraft design. The flight from England was completed in a little over ten days, and the record is thus beaten by over four days. The airman's previous flights had been made in a Fokker monoplane, and it is interesting to note that the record has been broken by a British machine equipped with a British engine.

* * * * *

On 10th October, the delegates to the Imperial Conference were invited by Dr. Henry S. Wellcome to meet the Fellows of the Royal Anthropological Institute, the members of the International Institute of African Languages and Cultures, and the members of the African Society, at the Wellcome Historical Medical Museum. In the course of the evening a short address was given by Lord Lugard, in which he outlined briefly the objects of these Societies, and pointed out the practical bearings of the studies with which they were concerned on the administration of the affairs of the backward peoples in our dependencies. He urged that the aim of those responsible for the government of such peoples, whether in India or in Africa, should be directed not to imposing the civilization of the white man on the non-European, but to assisting him along the path of development through his own customs and institutions, suppressing or modifying only those customs which were entirely repugnant to our sentiments and ideas, such as human sacrifice and head-hunting. In order to achieve this end with any measure of success, it was essential that native institutions should be studied sympathetically in accordance with the principles of anthropological science.

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It is an illuminating illustration of the views expressed by Lord Lugard that the recent rising in West Africa, where the principle of governing the native through his own institutions was established by Lord Lugard, is said to have been aggravated by the imposition in one area of a native form of government in circumstances to which it was not adapted. Outwardly in conformity with the principles of government laid down by Lord Lugard, in fact it violated them. Previous study of the conditions on scientifi lines would have averted this cause of unrest.

* * * * *

The bimillenary of Virgil's birth was celebrated throughout Europe last month. In recent years the works of ancient writers have been subjected to the closest study by modern scholars, and few revelations have been more illuminating than those concerning Virgil. Readers of *Discovery* are familiar with some of these discoveries, which Professor R. S. Conway has described from time to time. On the eve of the bimillenary Professor Conway lectured to the British Academy on "Virgil's Creative Art." Discussing the poet's sense of mystery, the lecturer said that its source was to be found in his profound sympathy with the joys and sorrows of humanity, and of the whole sentient creation. The same insight had given Virgil the power to transcend and so to reconcile even the most sharply opposed schools and parties of his time in philosophy, politics and religion. "No one of these sides of human life was the same after it had been touched by the fire of Virgil's genius; and no reader of Virgil in any age was ever the same if he could realize the warmth and the splendour and the mystery of the world as interpreted by Virgil's art."

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An important development in railway travel is foreshadowed in Germany by the invention of a saloon coach, driven by an aeroplane engine, which is capable of a speed of 93 miles an hour. The coach was tested last month on an experimental track between Hanover and Hamburg, and is constructed of steel tubing, covered with sheet aluminium and balloon fabric. An attractive new feature is a secret method of springing, which is so effective that the passengers in the experimental trip were unaware of any vibration or swaying movement. In next month's issue of *Discovery*, we shall describe a new British "railplane" invention which has recently been tested with satisfactory results. Under favourable conditions, it is anticipated that a speed of 120 miles an hour will be possible.

* * * * *

A British expedition is to start early in 1931 to the Western Himalaya, where an attempt will be made to ascend Mount Kamet. The mountain is over 25,000 feet in height, and is the second highest peak in the British Empire. Several well-known mountaineers have already tried to climb to the top of Mount Kamet, so far without success, and considerable interest attaches to this new attempt. The most successful effort was that of Dr. Kellas who climbed within 2,000 feet of the summit.

Birds of the North Atlantic.

By V. C. Wynne-Edwards.

Of the hundreds of bird-lovers who cross the Atlantic every year, how many attempt a systematic observation of the birds they see? With the aid of a map showing the route of a recent trip to Quebec, an expert here outlines the distribution of various species, and stresses the value of more widespread observation.

Last September, when crossing from Southampton to Quebec in the *Empress of Scotland*, I made a log of the birds seen on the voyage. Many people must sometimes have felt inclined to make observations of this kind, and it might add to the interest of their occupation if they knew something about the birds they were likely to see, and realized how valuable their observations might become. The number of species is not great. They constitute a class of gipsies among birds wandering up and down the world, and most of them are new to the landsman. Their movements are not altogether haphazard, however, and I have tried to make a picture of their distribution at this season, a distribution that is always changing and yet always being repeated as each year goes by.

The map on page 361 shows the track of the liner on Mercator's projection. It shows days and nights and times when a watch was kept. It illustrates also the edge of the continental shelf, which divides the permanent ocean from the narrow seas. This division is one of the most marked in marine ecology, and affects not only the animals of the sea bottom and the fishes, but also the plankton, that teeming layer of minute animal and plant life which drifts along within a few fathoms of the surface, and has been well called the pasture of the sea. The reason for this is probably to be found in the circulation, the physics and chemistry of the water, which change comparatively rapidly from the ocean towards the land; the same cause, whatever it is, also affects the birds.

The Sea-gull not Oceanic.

It is a surprise to most people to discover that sea-gulls are not oceanic birds. The black-headed gull, for instance, is closely tied to the shore. The herring gull and the two black-backed gulls make longer journeys out to sea and often follow boats across the Channel or the Irish Sea. The kittiwake is the most marine of the British gulls; it seldom comes ashore except for breeding, but at the same time it does not go far out to sea. Sailing out from harbour, kittiwakes are met as soon as land is cleared; they collect from all sides on the fishing grounds when a trawler hauls her gear, attracted, I have often thought, by the white column of steam from the funnel when the winches are working. Over deeper water, as between the Lizard and Ushant, they become scarcer and on the high seas they are merely vagrants. Actually, the last gulls seen on the way out from Cherbourg were lesser black-backs, which were observed some way west of the Scillies (8° 30′ W.). About a hundred miles west of this that other common bird of the English coastal waters, the gannet, reached its limit, and almost at once the true oceanic birds of the family *Procellariidae* were seen.

Distribution of Sea Birds.

A clearer idea of the distribution of sea birds is obtained by picturing zones running parallel to the coast. The first zone would be a narrow one, skirting close along the shore, including creeks and bays and estuaries, where the black-headed, common and herring gulls feed, and the shags and cormorants. The next zone would include all the narrow seas up to the edge of the continental shelf. Here there is a great variety of species, for example, kittiwakes, gannets and the auk family—razorbills, guillemots and puffins. A few members of the *Procellariidae* are found in this zone, such as the Manx shearwater and Mother Carey's chickens or stormy petrels. The birds of this second offshore zone differ from those of the first in that they do not come ashore except to breed, while those of the inshore zone often land and sometimes sleep ashore. The third zone is the ocean beyond the continental shelf. Here the birds are cosmopolitan for the most part, and are confirmed wanderers; they have a highway round the world and are as much at home in the Pacific as in the Atlantic. It is these birds which the landsman only sees if he visits their breeding places, and which follow in the wake of ships a thousand miles from land. Last September there were three abundant species of *Procellariidae*, the fulmar, the great shearwater and Wilson's petrel.

The first fulmars were observed about 10° 40′ W., while there were still a few gannets to be seen. A

stuffed fulmar in a glass case looks rather similar to a common gull at first sight, but the living bird, alternately flapping with strong steady beat and gliding on broad curved wings, is very different from any gull. It is white except on the upper side of the wings and back, which are a pale and slightly brownish grey. It is more sturdy and has a thicker neck than a gull. The young are speckled brown, with a pale, almost golden patch on the outer flight feathers and a white tip to the tail When gliding into the wind, the bird opens its flight feathers like fingers and closes them as it banks over at a high angle and makes off to leeward. It has recently been put forward by Lieut. R. R. Graham, R.N., that this separation of the primaries, seen in many birds, is Nature's version of an ingenious safety device known as the Handley-Page wing slot, which prevents aeroplanes from stalling, as paper darts do, when flying too slowly to obtain sufficient lift without it. It is worth noticing that the fulmar spreads its feet on either side of the tail to assist in steering, just as razorbills and puffins spread theirs.

Abundance of Fulmars.

Like most of the northern sea birds, fulmars breed on both sides of the Atlantic. On the way across they were fairly abundant, except just in the middle, till we reached the boundary of zone two on the other side, off the coast of Labrador. The great shearwater (*Puffinus gravis*) on the other hand, was not seen until we were at 21° 30′ W., and was decidedly more common on the western side. This bird is about the same size as the fulmar and roughly the same shape. Its wings are fairly dark brown above and there is a conspicuous white patch at the base of the short sooty black tail. The best character, however, is the deep brown cap on the otherwise white head and neck. The bird is a dirty white underneath and has an inconspicuous brown mark on the belly. It does not fly as high as the fulmar, but glides within a few inches of the waves in true shearwater style. Like other petrels, it is a surface feeder and was notably most common in the vicinity of whales and porpoises. One calm dawn (40° 30′ W.) I saw a very large school of porpoises, at a distance of about a thousand yards, churning the glassy flatness of the water like breakers on a reef, and round them were scores of great shearwaters and fulmars. Wherever there were whales spouting there were sure to be great shearwaters about; it seems likely that they feed partly on the leavings and faeces of whales.

Altogether different from these two birds is Wilson's petrel, commonly known as Mother Carey's chickens, although this name is applied correctly only to the stormy petrel. It is a small blackish bird with a white rump, about the size of our nightjar and with the same buoyant and erratic flight. To anyone familiar with the nightjar the resemblance of flight and form is very striking. Wilson's petrel is considerably larger than the stormy species, and reminds one of an outsize house-martin. It is distinguished from Leach's petrel, which breeds in the British Isles, by being sooty brown and not slaty-grey above, and by having a paler brown patch on the upper wing coverts. Both species have forked tails, although statements to the contrary are sometimes made, but the emargination of the tail of Wilson's petrel is very slight, particularly when it spreads the feathers. In a wind, these birds fly faster and twist and turn from side to side and up and down in a most uncontrolled manner.

Both this and the great shearwater are particularly interesting because they breed in the southern hemisphere and winter in the northern. We are familiar with the migrations of our own summer residents, a good many of which spend the winter in the far south, but it seldom occurs to us to ask why we have no southern species "wintering" here during our summer: these are two of the only cases. The great shearwater breeds on the Trista da Cunha group and perhaps elsewhere; Wilson's petrel breeds in Kerguelen, South Georgia, and on the Antarctic continent; both wander to the ends of the earth at other times of the year, some spending the months of the Antarctic winter in the north Atlantic.

American Zones.

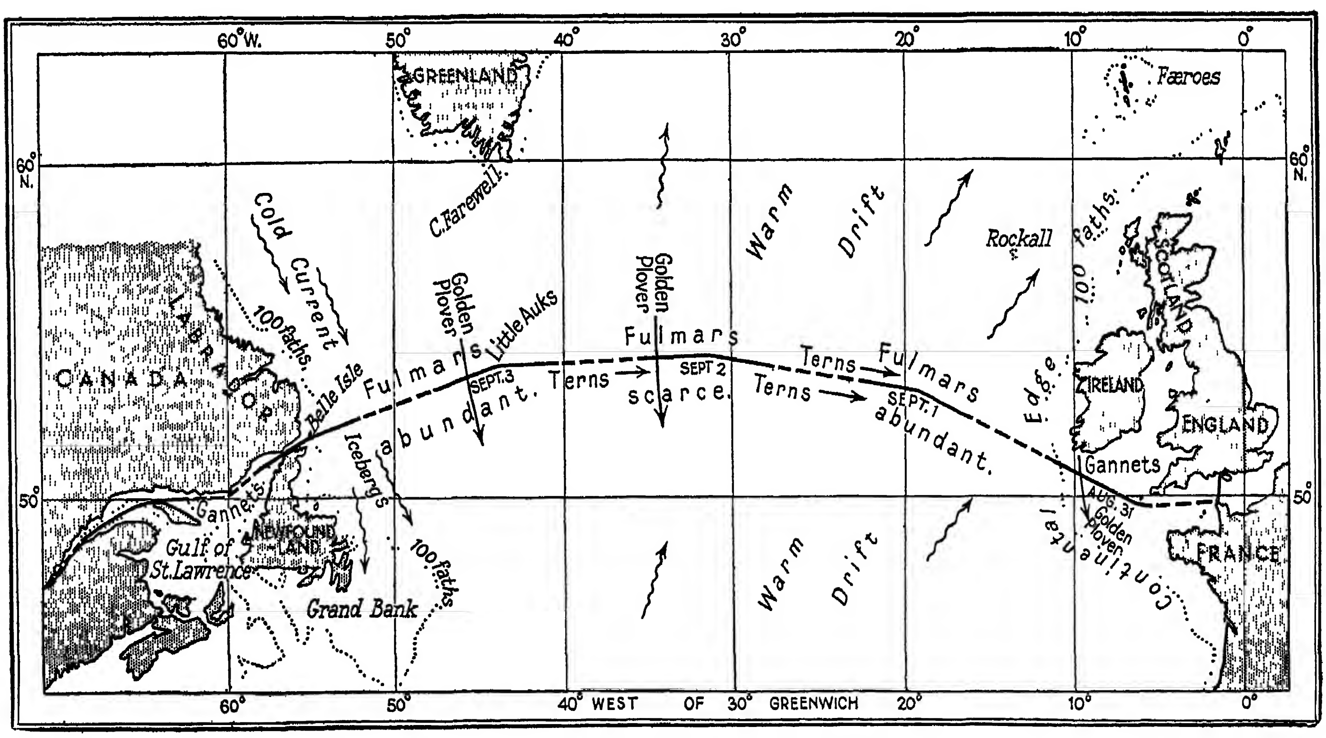
On the American side the same zones are apparent. The continental edge, as can be seen from the map, is quite close to the land off Labrador and north Newfoundland, so that oceanic conditions obtain right up to the mouth of Belle Isle Strait. Three fulmars were seen actually within a mile of Belle Isle, though they had ceased to be plentiful about fifty miles before we reached land. Wilson's petrels disappeared about forty miles east. The great and sooty shearwaters came some way into the Gulf of St. Lawrence, but only in small numbers. A greater black-backed gull and a party of kittiwakes appeared twelve miles east of Belle Isle, and four herring gulls flew by as we steamed along the north Newfoundland coast. Then as we got clear of the Strait and out into the Gulf of St. Lawrence, we were back again in zone two, with the same birds as are seen in the English Channel—puffins, gannets, kittiwakes, and occasional great shearwaters.

Off the north coast of Anticosti there were at one time forty-three gannets in sight on one side of the ship, but shortly afterwards they completely disappeared. From that point to Quebec we crossed three hundred miles of the most birdless water I have ever seen; apart from a single white-winged scoter and a very occasional gull, there was never a bird to be seen The water had changed from blue-green to a deep olive colour, probably brought about by an exceedingly fine suspension of sediment and by the admixture of fresh water from the St. Lawrence River. It was to some extent an enormous replica of the almost equally birdless Bristol Channel, where the mud and fresh water kill the plankton, and consequently impoverish all marine life to such an extent that it will not support any sea birds except the scavenging gulls which follow the shipping.

Before leaving this subject there are two points which may be emphasized. The first is the fact that almost all the sea birds on both sides of the Atlantic are the same. There is nothing very striking in this, in fact, it is the exceptions—the black-headed, common and lesser black-backed gulls, and the shag and cormorant of the European side—that are more notable, illustrating how coast-limited are the wanderings of these species. The other point concerns the ecological zones which I have outlined. These zones are not always sharply separated from one another, although they are so as a rule. In the same way, though not without many exceptions—two little auks, for instance, were seen four hundred miles off Labrador—it appears that the three principal families of sea birds, namely, the *Laridae* (gulls), *Alcidae* (auks) and *Procellariidae* (petrels and shearwaters), are each typical of one of the three zones. So that instead of the names inshore, offshore and oceanic, we might say gull zone, auk zone and petrel zone.

So far no mention has been made of the skuas, of which two species were seen. Skuas are predatory wanderers, swooping down wherever a group of gulls or terns has found something to eat. They are a branch of the gull family themselves but are dark brown in colour instead of white. They are wonderfully agile and swift on the wing and obtain much of their food by chasing gulls and frightening them, so that they disgorge all their food. The skua sweeps down and often catches the food before it reaches the water. At other times, however, skuas fish and scavenge for themselves.

The two species seen were the Arctic and great skuas. The Arctic species is a graceful gull-shaped bird, deep brown above and cream-buff on the breast. The yellow covers the lower part of the head and meets on the top of the neck, giving the bird a brown cap not unlike that of the great shearwater. The two middle tail feathers are elongated and pointed, which is the best distinction of this species from the closely similar pomatorhine skua. Arctic skuas were numerous all the way across from about 10° W., and a few were seen in the Gulf of St. Lawrence; great



DISTRIBUTION OF NORTH ATLANTIC BIRDS.

This map, which was compiled by the author on a voyage from Southampton to Quebec, shows the times when a watch of the birds of the North Atlantic was kept.

skuas were much less abundant. These are much larger and heavier birds, more hawk-like, and with a prominent white patch on the wing at the base of the primaries. Both species are very powerful fliers, and independent of any zone. I have sometimes seen great skuas in the English Channel and the Irish Sea at this time of year within a dozen miles of land.

Migration of Terns.

There is still the most interesting side of the observations to relate. About 20° W. we met five terns going east; five hours later there was a party of fifteen, with four Arctic skuas attending them, travelling in the same direction. On the following day, 2nd September, in the course of three and a half hours' watching, I saw a hundred and five terns, still going east. Next day, there were not so many, but small bands were seen frequently until 5 p.m., in long. 46° 30′ W. With two exceptions, every single one of these birds was on a course lying between E.N.E. and E.S.E. It is to be borne in mind that a ship steaming west at twenty miles per hour would naturally pass more birds going the opposite way than in any other direction. Even so, there is no doubt that we were observing a definite and prolonged movement of terns from west to east. There is confirmatory evidence. When terns are fishing, they do sometimes sit on the water to eat what they have caught, but they do not do so nearly so freely as gulls. None of these terns seen on the Atlantic ever stopped to fish, and only three were resting—not on the water but on driftwood and floating boxes, hundreds of miles apart. They were fasting, like most migrating birds. It is difficult to distinguish the species on the wing, but I believe all these were Arctic terns.

All the birds observed so far have been web-footed and are therefore at home on the sea; the terns, perhaps, less so than the others. On four out of the five days of open sea, however, real land birds were seen, utterly unable to alight on the water and without food. As we passed about a hundred miles south of the Irish coast, I saw a sand-martin and another unidentified passerine bird on their southward migration. The other land birds, except one, were all waders; I think the exception was the golden plover. One was at 9° 30′ W., flying south from Ireland; the second, two days later, was in mid-ocean, six hundred miles south-east of Greenland, 34° 30′ W.; the third was about five hundred miles due south of Cape Farewell, Greenland, 42° W. It is difficult to be sure of the identification, because the birds are seen and lost in a few moments, but all were either golden or grey plovers (*Charadrius sp.*). These birds are famous for their stupendous migrations. Excepting the first one, it is unlikely that they reached land before the Azores, more than a thousand miles further south; possibly they never reached it at all. At present, no one has the slightest idea of how these birds manage to shape a course and keep it on their journeys across the sea. The other wader was probably a Hudsonian curlew, not distinguishable in flight from our whimbrel. It remained for some minutes round the ship, about ten miles off the Labrador coast.

There are probably quite a number of accounts of these birds seen on migration so far out to sea, although I have not come across them. There is a great deal of investigation of this kind still to be done, and it would pay those interested in birds who cross the Atlantic to keep a sharp look out. There is also practically nothing known about the seasonal distribution of marine birds. If voyagers all pooled their observations, we should be able to make maps showing how, for example, the fulmars radiate out from their breeding places on either side, and gradually bridge the ocean; how the great shearwaters and Wilson's petrels work up from the south, and return there again. On this voyage there were scarcely any fulmars, only eight being seen throughout the day, between 28° and 36° W., that is, in mid-ocean. But there were hundreds of them, even thousands in the course of the day, nearer each side. One is led to suppose that by the first week of September the business of dispersal from their breeding places is not complete.

Science at London University.

In recent years science courses do not appear to have been in very great demand in university extension work in London, but the current programme issued by the University of London shows that lectures on scientific subjects are coming again into popular favour.

Foremost among the courses arranged is a series of twenty-four lectures on Modern Ideas and Work in Zoology. The time of the lectures—six o'clock—should prove helpful to those city workers who are interested in this subject, and desire to hear of the most recent advances and the outlook for the future. Courses in Evolution, Heredity and Biology will be given in such widely separated parts of London as New Cross, Stratford and Woolwich; and an introductory course in Psychology will also be conducted. Details regarding these and other courses may be obtained from the University.

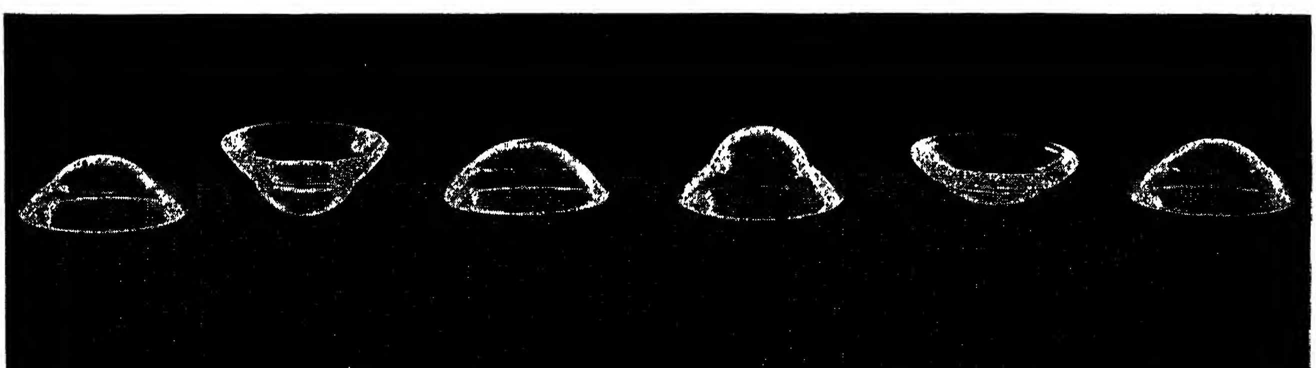
No More Spectacles?

New experiments with "contact" eye-glasses, which dispense with frames and are held in place by adhesion to the eyeball, have recently aroused considerable interest. The glasses, illustrated below, are thin shells made of optical glass which can be worn under the eyelids and in contact with the eyeball. In 1888, Dr. A. E. Fick, of Zurich, an eye specialist, invented contact glasses mainly for the correction of a condition of thickening and arching of the cornea; the so-called "Keratoconus," which reduces the power of sight. It was soon seen that the keratoconus was not only corrected by reason of the fact that the contact glasses acted as an orthopaedic support on the cornea, but in addition there was actual healing. The contact glasses lie over the cornea and the pupil, and the border rests on the sclera. The cornea part is a carefully cut bowl, and its purpose is to correct eyesight errors; the border should adhere to the eyeball with only a thin layer of tear excretion between.

It was thought that the contact glasses might be used for the benefit of far or short-sightedness, and numerous experiments were made. The real advantage was discovered to be in the fact that as the contact glass rests on the eyeball, it follows all the movements made with the eye, and therefore remains in focus. The great disadvantage of spectacles is the fixity of their optical axis with which the axis of the eye does not always register. With the contact glasses, which follow the movements of the eyes, the axes naturally always fall together and the picture is sharp in all directions. There is no restriction of view-field such as the size and form of spectacles bring about. For ladies and actors, for instance, a further advantage is claimed in that the wearing of contact glasses is not distinguishable, and for the short-sighted there is strong magnification of the picture on the retina. It is not expected that contact glasses may be worn, like spectacles, for indefinite periods, for after a while the pressure of the adhering glass on the sensitive surface of the eye may cause pain and discomfort.

Earlier this year Professor Heine, of Kiel, made experiments with various contact glass forms and reported corrections of eyesight failures by their use. He found that, after getting accustomed to the glasses, they could be worn in many cases to replace spectacles. In the treatment of keratoconus he noticed an improvement in short-sighted persons, and his experience, following that of Dr. Fick, will undoubtedly be carefully tested at various eye-clinics. The photograph reproduced shows several forms of contact glasses which have recently been prepared for the use of eye-specialists. After testing, the most satisfactory will be chosen for use. It is the bowl form which covers the cornea that corrects errors of sight, and particular attention will be paid to this in testing. The border lying on the choroid will also be tested in order to find the best curvation and to ensure that the glasses sit comfortably. Contact glasses up to six dioptrics come chiefly into question for correction of vision, since above this they would be too thick and too heavy. To begin with, a patient will wear them only for an hour at a time, and they will be placed into position and removed by the specialist until such a time as the patient becomes fully accustomed to the handling of the glasses.

In time, perhaps, the use of contact glasses will pass out of the sphere of experiment, and will take the place of spectacles, so giving the defective-sighted a better definition in colour and in perspective, as well as less unsightly eyewear.



THE NEW "CONTACT" GLASSES.

Several forms of the new "contact" glasses prepared for use by eye specialists. In forthcoming tests, the most satisfactory type of glass will be selected for practical use.

The Men of the Trees.

By R. St. Barbe Baker.

Increasing deforestation raises a world-wide problem of economic as well as industrial significance. A society of tree-lovers, founded among African natives, has already done much for the preservation and planting of trees in many parts of the world, and is about to launch an extensive campaign in Wales.

To create a "tree-sense" and to encourage everyone to plant trees everywhere is the ideal set forth by a new society of tree-lovers with world aspirations. The world needs trees to-day as never before and each year, as scientific knowledge advances, many new uses are found for forest products, before the war the articles generally made from wood were numbered at five hundred, to-day, with the development of the cellulose industry, something in the neighbourhood of four thousand uses for wood or wood products can be counted

Trees, apart from their direct economic value, exert a beneficial influence affecting climate, agriculture and the very existence of man. This can be more clearly demonstrated in Africa, where vast areas are drying up and becoming de-populated as the direct result of forest destruction Recent scientific research has shown that the Sahara has not always been desert, and remains of trees have been found on the banks of vanished rivers and on the shores of dried-up lakes. A further interesting fragment of evidence goes to show that an early king of Egypt received a present of five hundred buffaloes from a place which is now near the centre of the Sahara. As all African sportsmen know, the buffalo prefers to inhabit districts in and around forest regions, grazing in the open parklands or on the fringe of a forest in the early morning or late evening, and lying up in the forest during the daytime. It would appear that at one time about a million Arabs settled in parts of Africa which are now desert. They cleared the forests to make their farms, moving on to repeat the same process of destruction as soon as they had reaped their crops. They brought with them vast herds of goats; it would be conceivable to estimate that each Arab possessed something in the neighbourhood of one hundred goats. A hundred million goats, following in the train of nomadic farmers, would not allow much tree growth; the goat, as is well known, is the *bête noir* of the forest.

A FOREST NURSERY

The Men of the Trees are pledged to do one good deed every day. Eighty thousand young trees were raised in this forest nursery by African natives as their "good deed."

To the north of the Gold Coast, in territory which comes under the French sphere of influence, it has been pointed out that racial suicide is being brought about as the result of forest destruction. In certain tribes, chiefs have forbidden marriage, while women refuse to bear children because they see the end of the forest in sight and they will not raise sons and daughters to starvation. They have been trapped in a wedge of the forest with desert right and left of them, and desiccation is travelling fast in their wake. In many instances, the shifting sand is burying their poor crops and driving them into the remaining wedge for their present cultivation. This is an extreme case, and graphically shows what may be the result of neglecting to form forest barriers when old primitive methods of shifting agriculture are in vogue. In the

wake of a destroyed forest large sandy wastes rapidly spread and are resulting to-day in the drying up of vast areas of this great continent.

When I first went into the Highlands of Kenya I came across a tribe of forest destroyers, and when I talked to them about tree planting everybody agreed that it would be a very good thing, but the problem was to persuade them to plant trees without payment or compulsion. I had given long talks in many meetings of chiefs, but apparently the seed had not taken root and no action had at first resulted. One day an inspiration came to me. I had been watching ceremonial dances and had learnt that, in these parts of Africa, there was a different dance for every season of the year. There was a special dance, for instance, when the beans were planted and another when the corn was reaped, and before setting out on a lion hunt the tribesmen stimulated their courage by a special dance. Even when there was apparently no particular object, they would frequently dance. Suddenly the idea came to me of suggesting a ceremonial tree-planting dance! Everywhere young African warriors were pouring a vast amount of life and energy into their warlike skirmishes, forest burnings and dancing. I was convinced that such an impulsive body of stalwart fighters could be influenced for good instead of being left to continue in old habits of destructiveness through sheer ignorance of better uses for their energy. I had thought of applying the principles of the Boy Scout movement but, when on a visit to Nairobi, I ventured to discuss the matter with brother officers, the idea of putting "natives" upon their honour was condemned as wildly impracticable. I was considered a visionary and, but for the encouragement of an American official, an Italian padre, and a British settler, I might not have persisted.

FOR MARGARINE

A Sobo native collecting palm produce which will eventually be used for making margarine. This is a minor product of the forest.

As it was the height of the dancing season, it occurred to me that here might be an opportunity for introducing a tree-planting dance and, in so doing, to reach the young blood of the tribe, for all the young men were passionately fond of dancing. First of all, I sent for the captains of the various N'gomas, or dances, and gave them an invitation to bring their followers and join in a competitive dance which I was about to arrange. This new dance, I explained, was to be the Dance of the Trees, and I promised a prize of a fatted ox for the best turned-out Moran. As their women could not possibly be left out on this auspicious occasion, a necklace of their favourite beads was promised to the most beautiful damsel. The winning Moran was to be chosen by myself, assisted by a committee of chiefs, and the damsel was to be elected by the popular vote of a committee of Morans, presided over by my prize-winner. The captains of the dances excitedly expressed their pleasure at this new idea, and hastened to their various towns and villages to spread the news.

At length the day of the great dance arrived. It was one of those perfectly fine days of glorious sun and crisp air to which one becomes almost accustomed in the delectable highlands of Kenya. As I dressed, I felt that at least the elements were with me, for the sun was already rising over the distant mountains, and when the early mists cleared the snow-capped peak of Kenya caught the morning sunlight, while her sister Kilimanjaro, a hundred miles away, resembled a giant's breakfast table spread with a snowy white cloth which overhung its square top. It was hard to imagine that one was on the equator, for in spite of the sun, as I sat down to breakfast I was thankful for a roaring fire. Early as it was the excitement had begun, for soon runners arrived to say that their tribesmen were approaching in thousands. Three hours later these eager young warriors were massing in a great column between two hills, about a mile from my camp, where they were sorting themselves out and putting the finishing touches to their elaborate make-up in readiness for a grand march-past. At

a given signal the great throng started to advance, rank upon rank, carrying their spears and shields. On they came in a constant stream, prepared as if for battle, yet on the spear points was the ball of ostrich feathers to signify that they came in peace. With proud dignity they marched past the raised platform which had been erected for the occasion and then, halted by their captains, they formed orderly ranks to listen to the address of welcome awaiting them.

That day, the Dance of the Trees was inaugurated, and in response to my appeal, and with the assistance of the chiefs, I picked out fifty for the trail experiment from five hundred volunteers, many were sons of chiefs and head men, and all of them came of yeoman stock. These fifty promised before N'gai the High God to plant trees and protect them everywhere A badge of office was there and then tied upon their left wrist to remind them of their vow—a small brass disc bearing the words "Watu wax Miti." The badge was fastened with a kinyatta, a narrow leather band, worked with green and white beads. Later, the well-known rule of the boy scouts, "One good deed each day," was added to this simple ceremony. After the first fifty, no more volunteers were called for; every new member had to be proposed by one of the chiefs, all of whom had already been initiated and given the rank of "Forest Guide," the equivalent of our scout masters. At first, this rank was only given to chiefs, although it is now open to any member who has introduced a hundred recruits who have proved their worth.

It was important to safeguard the organization and to enlist only those who had the ability to perform their promises, and nowadays it is generally the case that tree-planting volunteers are all yeomen with a recognized status in the country. Gradually, there came into being a simple initiation ceremony which is intended to express the spirit which characterizes the movement. This ceremony had a tremendous effect upon the simple and impetuous heart of the African warrior, as was shown when, some days after the first big initiation ceremony, a number of the new initiates came to my camp One stalwart spoke up for the rest: "Bwana, we have come to ask you to help us to think of a good deed In two hours the sun will go down and so far we have been unable to think of a good deed to do. Please help us." I was astonished; they wanted to do something very definite then and there to fulfil their obligation, so I suggested that there were thousands of young seedlings waiting to be planted out, and every man who planted his fifty might count this as his good deed for the day To this suggestion they willingly consented. Evening by evening they came to my camp and, when they could not think of a better deed to do, they planted out young trees, raising eighty thousand in the first nursery at Kikuyu. With the encouragement of interested chiefs, this good work has continued and has resulted in lasting benefit to their country. The story of how these forest destroyers became tree planters has spread

PREPARING FOR THE "DANCE OF THE TREES."
The inauguration of the society of tree-lovers in the Highlands of Kenya was marked by a tribal dance in which hundreds of natives took part

to other countries and has fired the imagination of youth for a practical ideal.

A YOUNG PLANTATION

Young teak trees planted by African natives who recognize the danger of widespread forest destruction. The plantation is only six years old and is now ready for thinning

At the invitation of Sir John Chancellor, I went to Palestine to assist in setting on foot the Men of the Trees in that country. A meeting was held in Jerusalem, when representatives of all sections of the community and the public in general were invited, and officers were appointed. I was privileged to take part in a tree-planting ceremony in which four thousand school children planted young trees along the main roads of the rising suburb of Bayit-Vegan; about sixteen thousand of the inhabitants of Jerusalem marched out to witness the ceremony. I found that the "tree sense" already existed to a marked degree among the Jewish section of the community. Considerable local interest in tree-planting was aroused, and in July of last year a letter jointly signed by Lord Allenby, Lord Melchett and Sir Francis Younghusband, chairman of the Men of the Trees, appeared in the Press, drawing attention to the need of afforestation in Palestine and of voluntary effort to benefit this land of historic interest and future prospect. As a result of these and other steps taken, a sum amounting in all to over seven hundred pounds has been collected. Nearly sixteen thousand trees have already been planted in the Judean hills on the road from Jerusalem to Jaffa, the chief species being the Jerusalem, Italian and Austrian pines, the hackberry, Palestine oak and juniper. The work is still in progress, and the coming season is full of promise.

I also visited Canada and the United States of America to further the ideal of the Men of the Trees in those countries. Among one of my most appreciative audiences were military cadets of the Citizen's Army Training Camp, where I spoke to over twelve hundred at the request of the commanding officer. A conversation with President Hoover showed his keen interest in the conservation of the forest resources of the United States, and particularly in the work of the Men of the Trees. That same night in Washington, I met a hundred and fifty foresters from all over the Eastern States and conferred with them for over four hours. I found them fully alive to the seriousness of the forestry situation in their country, where they have cut over seven-eighths of their virgin forests and are using four and a half times as much as they produce every year. Canada and the United States, with one-twelfth of the world's population, use half its forest products,

This year, the Men of the Trees in Britain are making a special endeavour with a view to assisting employment in the distressed mining areas. The Welsh hills are the natural domain of forests, and the coal beneath the surface is evidence that vast forests have been buried. Even at high altitudes, there is evidence that, when once established, certain trees of economic value will thrive. Added to this, the floods of last year have emphasized the importance of re-afforestation Tree planting is a task to which willing workers may be quickly trained, and the fencing of the areas to be planted can be carried out immediately. Scattered areas of land in the distressed districts are available for planting; one of these sites is at Brynmawr.

We have our training site in view which may be acquired by the Men of the Trees, and under proper supervision those who are unable to obtain employment elsewhere may be encouraged and instructed in their new work. The Men of the Trees have undertaken to raise a fund for this valuable work of reconstruction in Wales which, while affording immediate employment, will bring lasting benefit to the community. At the back of the idea of planting a tree is the spirit of constructive service; the beauty of the countryside which we enjoy to-day is a heritage from the past, and we may well ask what we are doing to pass on this legacy to successive generations.

Measuring the Temperature of Stars.

Recent research in America has enabled astronomers to measure the temperature of stars which are over six hundred times fainter than those barely visible to the naked eye. An attempt will shortly be made to discover the nature of the rocks which compose the surface of the moon.

Many of the instruments used in conducting present-day scientific research are of extraordinary sensitiveness and precision. This is particularly true of a device called the thermocouple, an improved type of which Dr. Edison Pettit and Dr. S. B. Nicholson, of the Mount Wilson Observatory, have recently developed and which they are using in measuring the heat of stars and planets. Employed as it is with the hundred-inch telescope, it is so sensitive that the heat of a candle one hundred miles away could be detected with it were there no loss of heat due to absorption by the atmosphere.

An Impressive Feat.

With this instrument these investigators have accomplished the astonishing feat of measuring the heat radiation of a star of the thirteenth magnitude. This achievement is impressive when it is recalled that stars just visible to the unaided eye are of the sixth magnitude, and that the faintest stars photographed with the hundred-inch telescope at Mount Wilson, the most powerful telescope yet constructed, are of magnitude twenty-one. A star of the thirteenth magnitude, therefore, is about 631 times fainter than the faintest star which most of us can see, and yet this instrument is responsive to the heat which can be focussed on it from such a star. This exploit becomes even more impressive when it is realized that a star of the sixth magnitude, that is, one which can barely be seen, radiates upon the whole United States no more heat than the sun radiates upon one square yard of surface. Yet, in the case of such a star, the thermocouple will show that the increase in heat on account of it is one-half of one-millionth of a degree Fahrenheit, and that the electric current generated thereby is about one twenty-billionth of an ampere. This value becomes intelligible in consideration of the fact that the light in an ordinary incandescent house lamp is produced by a current flowing through it of from one-fourth to one ampere.

The heat of a star of the thirteenth magnitude produces a proportionately feebler current, yet a current that is not too feeble to be detected and measured. The extreme sensitiveness of the thermocouple is again illustrated in the case of stars as they rise above the horizon. The higher they ascend the brighter they appear to grow, because the higher they rise the less of the Earth's atmosphere their rays are obliged to penetrate and consequently the less their rays are absorbed. The sensitivity of the thermocouple is so great that with bright stars near the horizon the change in brightness which takes place in one minute of time can be detected.

The principle upon which the thermocouple is based can be grasped from the diagram opposite. Two strips or wires of different metals, iron and copper for instance, are welded together at their ends, Z, T. One of them, the copper strip in the diagram, is cut and an instrument, G, a galvanometer, very sensitive to electric currents, is inserted. A complete electric circuit, of which the galvanometer is a part, is thus formed. When one of the junctions, T, is heated to a higher temperature than the other Z, an electric current is set up, the strength of which, as recorded by the galvanometer, varies as the difference in temperature varies between the two junctures. For example, if a lighted match be held at T while Z is kept cool, the galvanometer quickly registers a current. If ice be applied to T and it becomes colder than Z, the current flows in the opposite direction. It was upon this principle that the original vacuum thermocouple was first developed. Pettit and Nicholson have improved the instrument with marked success.

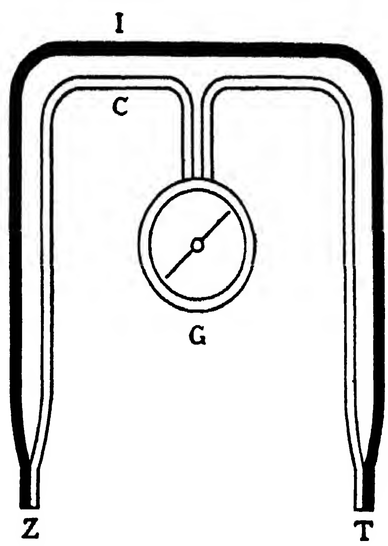
Construction of the Thermocouple.

The essential part of the thermocouple consists of two exceedingly minute wires fused together at the ends. One of these is of bismuth, the other is of an alloy of bismuth containing five per cent of tin. These are connected electrically to a galvanometer in such a manner that the currents produced when the junctions are heated separately flow in opposite directions. Small thin metal plates are fused over the junctions of the thermocouple wires and covered with a mixture of lamp-black and platinum-black on their exposed surfaces. These black plates absorb all the radiation

* This article is based on a report received last month from the Carnegie Institution, Washington.

from celestial objects within about two per cent and convert it into heat. To reduce the loss of the star's heat from conduction, the thermocouple is operated within a vacuum. The weight of a complete thermocouple, including the metal receiver and connecting wires, is about one-tenth of a milligram or about one one-thousandth the weight of a drop of water. The mass of the receivers themselves, the parts of the apparatus upon which the heat rays of the stars are focussed, is only about a third that of the complete thermocouple.

In practice the instrument is mounted upon the hundred-inch telescope, which is trained upon the star to be examined. The rays of the star fall upon the concave mirror of the telescope, whereupon they are focussed upon one of the junctures of the thermocouple corresponding either to T or Z in the diagram. Currents produced in this way are proportionate to the amount of heat received by the thermocouple, so that the deflection of the galvanometer, when a star is focussed on the thermocouple, is a measure of the heat received from the star. The deflections of the galvanometer thus induced are recorded photographically. Under favourable conditions they can be measured with extreme accuracy. Thousands of observations have been made with the thermocouple and have lead to conclusions of the greatest importance regarding the condition of stars and planets.



PRINCIPLE OF THE THERMOCOUPLE.

When a star is focussed on the instrument, a deflection of the galvanometer 'G' records the heat. The diagram is described in the text.

With this instrument it has been found that stellar temperatures range from 23,000° C. absolute (41,000° F.) for the very blue stars like Zeta Orionis, to 6,000° C. absolute (10,000° F.) for those like the sun, and 1,800° C. absolute (2,800° F.) for the very red long-period variable stars like Omicron Ceti. The hottest stars do not necessarily give us the most heat. They radiate the most heat per unit of area, but a cooler star may be so much larger that its total radiation exceeds that of the hotter star. This is illustrated by an electric light and an electric stove. The filament of the light is much hotter than the wire coil of the stove, but the latter is so much bigger that the total energy radiated from the stove is much greater than that from the light. On the other hand, the electric lamp gives more light than the stove.

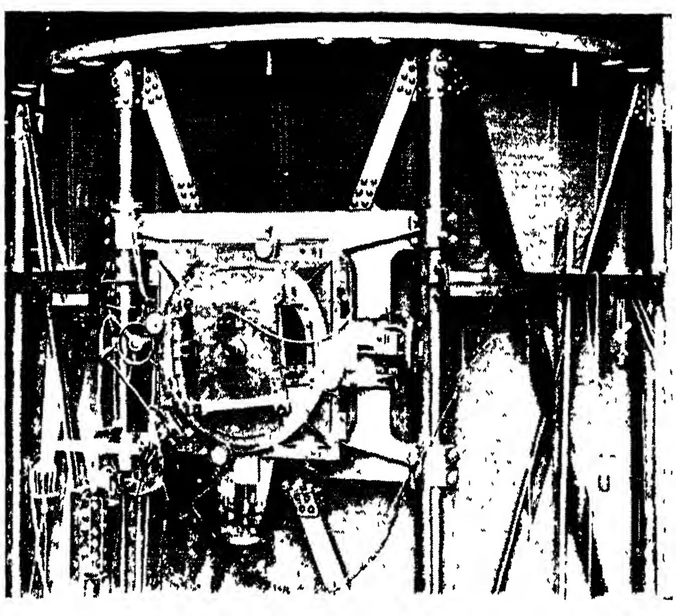
There are stars like the electric light—small, very hot and bright, with comparatively little heat outside the visual region; and there are stars like the stove—big, comparatively cool, and faint visually but with an enormous amount of heat radiation, which can be measured with the thermocouple. The coolest stars observed are the long-period variables. Because they are so cool they are very red and give very little visual light in proportion to their heat. The coolest of these which has been measured is Chi Cygni. At minimum brightness its heat is equal to that of a hot star fifty thousand times as bright. It is possible that there are still cooler stars which give little or no light, the heat of which could be measured with the thermocouple if the astronomers knew where to find them.

If the temperature of a star is known and the total amount of energy radiated from it can be obtained, its diameter may be calculated. If the distance to the star is known, the total radiation from it can be obtained from that falling on the mirror of the telescope, which is the amount measured. Without knowing the distance to the star, however, its angular diameter can be obtained. The angular diameters of some of the largest stars have been measured directly with the stellar interferometer. The values obtained from heat measures, while in most cases somewhat larger than those obtained with the interferometer, are of the same order of size. They tell us, for example, that the star Sirius, although much hotter and closer to us, is so small that the total heat from it is about equal to that from the big star Betelgeuse, which is over thirty times as far away. The diameter of Sirius is one and a half times the diameter of the sun, while the diameter of Betelgeuse is more than two hundred times that of the sun.

The vacuum thermocouple, attached to the hundred-inch telescope, has also been used to measure the temperatures of the planets and, still more recently, the temperatures of various regions of the moon. Our knowledge of such temperatures, as well as of the temperatures of the stars, comes from a study of the amount and quality of the radiation which reaches us from them. The moon and the other planets, of course, are much cooler than the stars;

consequently the light that we see when we look at them is reflected sunlight. But they also radiate energy-waves of lengths too long to be visible to the human eye. This part of the radiation is called planetary heat. Planetary heat cannot pass through glass, for the wave-lengths are too long, whereas reflected sunlight can. It is therefore easy to separate the one from the other by placing a thin glass screen in the path of the radiation. In practice, the planet to be studied is first observed without any glass in the optical path of the telescope. The thermocouple is then heated by all the heat from the planet, planetary heat and reflected-sun heat, most of the latter being visual light. Next, a thin piece of glass is placed in the optical path of the telescope. This absorbs all the planetary heat, but transmits the reflected solar radiation. Since the distance of the planet and the area of the surface which is sending heat to the thermocouple is known, the temperature can be calculated from the amount of radiation which is sent us per unit area. The most uncertain part of the calculation lies in the correction which must be made for losses when the rays are passing through the earth's atmosphere. Atmospheric conditions on the planets are so different from those on the earth that the actual temperatures such as would be read if a thermometer were placed near their surfaces might differ greatly from those obtained by radiation methods.

Mercury is certainly very hot and has little if any atmosphere. The maximum temperature is about 700° C. absolute (800° F.). The distribution of radiation over its surface is much like that of the moon. Venus is covered with clouds. The radiation measured is from the high cloud surfaces and tells very little, except by inference, about the actual surface temperatures. The night temperature at this high altitude in the atmosphere of Venus is much greater than that on the surface of Mercury or the moon, being about 250° C. absolute (—9°F.). The temperature of Mars varies greatly with the season and the time of day, but the temperatures there are somewhat like those on the earth, at least like those at very high elevation where the atmosphere is rare. The outer planets are very cold, as might be presumed from their great distances from the sun, unless they give off heat from their interiors. Not many years ago it was commonly supposed that Jupiter was warm, probably warm enough to give out some light of its own. The thermocouple, however, shows that this is not the case, and that the temperature of Jupiter is about 135° C. absolute (—216° F.).



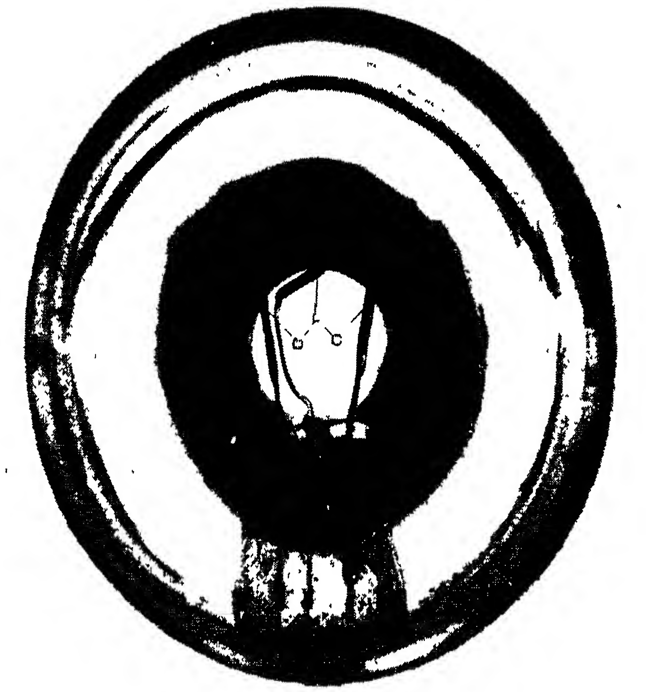
THE WORLD'S MOST POWERFUL TELESCOPE

The thermocouple is mounted on a hundred-inch telescope and is so sensitive that astronomers have been able to measure the heat of a star of the thirteenth magnitude.

The absolute temperature of a theoretically "perfect radiator" varies as the fourth root of the total radiation emitted by it from a unit area of its surface. The moon, strictly speaking, does not behave as an ideal radiator would, but for practical purposes it may be regarded as such. The measurements of the total lunar radiation, therefore, lead directly to estimates of the moon's temperature. From numerous observations during the last seven years, the temperature at the point on the moon where the sun is directly overhead has been found to be 118° C. (244° F.) at the time of full moon, and 65° C. (149° F.) at first and third quarters. The difference in these results, apparently, is caused by the roughness of the surface, which increases the radiation sent out in the direction of the lunar zenith and decreases that emitted toward the horizon. The true temperature lies between the figures given. Measurements made on the dark side of the moon gave —153° C. (—243° F.) for its approximate temperature. An accurate determination for this part of the moon will, however, require extensive observations, for the lowest temperature which can be detected with the instruments used (approximately —170° C. or —274° F.) is not much below that indicated by the observations thus far made.

The variation in the radiation, and hence in the temperature, over the sun-lit side of the full moon was obtained by allowing the image of the full

moon to drift across the receiver of the thermocouple while a moving photographic plate traced the resulting galvanometer deflections. The planetary heat varies from a practically unmeasurable quantity at the edge to a maximum at the centre. The changes in temperature which take place during a lunar eclipse were investigated at the eclipse of 14th June, 1927. For the point measured, the temperature fell from 69° C. (156° F.) to —98° C. (—144° F) during the first partial phase, continued to drop to —117° C. (—179° F.) during totality, and during the last partial phase rose abruptly nearly to the original temperature. The enormous fall in temperature of 186° C (335° F.) observed during this eclipse, the greater part of which took place during the partial phase, is in strong contrast to the fall of 2° or 3° C. (4° or 5° F.) observed at solar eclipses on the earth.



THE EYEPIECE.

An enlarged view of the eyepiece of the thermocouple showing the metal discs upon which the heat rays of the stars under examination are focussed.

This illustrates the governing effect of an atmosphere on planetary temperatures, since the only physical distinction between the factors involved in this comparison is the absence of an atmosphere in the case of the moon and its presence in the case of the earth It happens that the radiation from the sun runs to shorter wave-lengths than the radiation from the earth. It happens, also, that short waves go through our atmosphere more easily than long waves do. This is because of the presence in the atmosphere of carbon dioxide and of water vapour, both of which serve to differentiate wave-lengths. So our atmosphere acts as a sort of trap for heat-rays, letting in easily those from the sun and holding back those from the earth. Thus, the excessive cooling, which otherwise would take place at night, is prevented.

There is much more to be learned about the planets and the moon from thermocouple measures. It is quite probable that the observed rates of cooling and heating of the moon, as the amount of sunlight which falls upon it varies, may lead to very definite knowledge of the character of the rocks of which its surface is composed. In fact, laboratory study has already been made upon various earth materials—granite, lava, quartz-sand, and pumice, among others—heating and cooling them, observing the rates at which their temperatures change, and comparing the results with the rate of change which takes place on parts of the moon's surface as shown by the thermocouple. In attacking the problems presented by the surface features of the moon, a committee of scientists in America is seeking to ascertain the nature of the materials exposed at its surface and their behaviour under lunar surface conditions. When this information has been obtained, the committee expects to proceed to the classification of the surface features and to the analysis of the several hypotheses which scientists have advanced to account for them.

A National Folk Museum?

In *Discovery* for September an appeal was made for the preservation in a National Folk Museum of buildings of earlier periods and their contents. It was then pointed out that, unless such a collection were established, objects of value were likely to be thrown aside as rubbish to decay, when those who valued them had gone. It is now announced that the Government is considering the erection of a museum in the Royal Botanic Society's gardens in Regent's Park, where typical old cottages would be erected to house collections of period furniture and utensils. A committee has already been formed to consider the suggestion, which was made some time ago by the Royal Commission on National Museums. The Botanic Gardens has been suggested as a suitable site by a committee of the British Association and the Royal Anthropological Society, and it is understood that Mr. Lansbury has received the proposal favourably. When the Royal Botanic Society's lease expires two years hence, it will not be renewed.

British Universities To-day : (9) Manchester.

By Sir Alfred Hopkinson, K.C., B.C.L., LL.D.

Vice-Chancellor of the University of Manchester, 1900-1913.

The foundation eighty years ago of Owens College, which later developed into the Victoria University of Manchester, marked the commencement of the modern university movement in provincial towns. The close co-operation of teaching and research has been an important feature of the University since its inception.

The University of Manchester is really a development of Owens College, and the date of its foundation should be taken as 1850, when the scheme for carrying out the will of John Owens was completed, ready for the actual opening of the College on 12th March, 1851. The existing corporate body, however, of which the correct legal title is now "The Victoria University of Manchester," dates from 1880, when the first Royal Charter for the University was granted. It was right, therefore, that when the Jubilee commemoration was held in May of this year, the eightieth anniversary of the foundation of Owens College and the fiftieth anniversary of the grant of the University Charter should be celebrated together.

Foundation of Owens College.

The idea of a new university in a large town goes back to a date much earlier than the middle of the last century, for in 1640 a relative of General Fairfax drew up a petition praying Parliament that a university might be founded in Manchester. Objections were raised in York and the Fairfax proposal was not carried out. Another attempt was made late in the eighteenth century to found a "College of Arts and Sciences" with the help of the Manchester Literary and Philosophical Society, which has done so much to promote scientific research in Lancashire. At that time the population of Manchester appears to have been only about 36,000. A medical school, now incorporated with the university, was actually instituted in 1825. But the really effective start of the modern university movement in large towns, except London, was due to the action and wise forethought of John Owens, a Manchester merchant, and his friend, George Faulkner. It is said that John Owens, who was a bachelor, proposed to leave his whole fortune to his friend, but Faulkner said that he had already plenty of money and suggested to Owens that he should found a college. Owens felt keenly the disabilities under which Nonconformists were then suffering as regards education; but there is reason to believe that the scheme for the College was due to both friends, and certainly Faulkner, though a Churchman and a Tory, shared in carrying out the intentions of Owens to found a college on an undenominational basis. Owens died in 1846 and his residuary estate, which was to be devoted to the foundation of the College, amounted to £96,954.

The wise forethought shown in the provisions of his will pointed out the true lines on which the colleges, which were the pioneers of new universities, should act if they were to succeed and the nature of the ideals they should put before them. His endowment was to be to provide (or aid) "the means of instructing and improving young persons of the male sex of at least fourteen years of age" in such branches of learning and science as are usually taught in the English Universities, but subject to the two following fundamental immutable rules and conditions: "that the students, professors, teachers and others connected with the said institution shall not be required to make any declaration as to or submit to any test of their religious opinions, and that nothing shall be introduced in the matter or mode of education or instruction in reference to any religious or theological subject which shall be reasonably offensive to the conscience of any student or of his relations, guardians or friends."

It was at one time thought that this clause forbade any instruction of a theological kind and even lectures on the languages of the Old and New Testament, but after legal advice had been taken, a course of free lectures was given every year by Dr. Greenwood on the Greek Parliament, and the first principal, Dr. A. J. Scott, gave addresses on religion in relation to the life of the scholar. In 1904, after the grant of the existing charter of the university, a free theological faculty was instituted in Manchester, which has been most harmonious and successful and forms a model for action of similar character in other places.

One of the most valuable conditions laid down by John Owens was that his gift was not to be spent

on buildings, but on making provision for a proper teaching staff; and when the work of the College was started, an old house at the corner of Byrom Street in Manchester, which had once been the residence of Richard Cobden, was taken for it. The number of the students was very small and actually diminished after a short time, but the quality of the teaching staff was excellent. It was thus possible to weather the period of depression, whereas, if the money had been spent in buildings, they would probably have proved useless and been disposed of for some other purpose, and thus permanent injury would have been done to the modern university movement. It is worth notice that, when Mr. H. O. Wills gave over £100,000 for the University of Bristol, he directed that the money should be applied for the endowment of chairs to secure proper teaching of university character. Buildings on a magnificent scale, given by his son, followed some years afterwards in due course.

"Learning" as well as Science.

It was also a wise provision which directed that the subjects taught at Manchester were to include "learning" as well as science, making it clear that the founder's object was not to endow a technical institute or a college limited to natural science. From the beginning, the arts side received equal attention within the college, although in the eyes of the general public its work in natural science attracted more notice, as the older universities at that time did comparatively little either in teaching or research, for experimental science. The first four Principals and also the present Vice-Chancellor were "Arts" men. It was largely due to the steady work of Dr. Greenwood, the second Principal, that the number of students rose from 33 in the early 'fifties to over 1,000 day students in 1900. Though no doubt many came very imperfectly prepared, the tone was good, the students were warmly attached to the college and their teachers, and long before the grant of a University Charter many who attained highest distinction had been trained in the college. Among other names of students going back to the period before the Charter of 1880 may be mentioned William Broadbent, Thomas Barlow, Norman Moore and Julius Dreschford in Medicine; and John Hopkinson, Horace Lamb, J. J. Thomson and J. H. Poynting in Mathematics. The work done in chemistry was perhaps most remarkable, from the days of Frankland, the first professor, who was followed by Roscoe and Schorlemmer, down to the present time. For many years a large number of the professors and lecturers of chemistry, both in England and Dominions overseas, were trained in the Owens College laboratories.

Before 1870 the College had quite outgrown the old building, and a movement was set on foot for acquiring a new site and for erecting new buildings. No help could then be obtained from the Government or local authorities, but a site was acquired, of which the less said the better, and a portion of the present buildings was opened in 1873. About the same time the old Manchester Medical School was incorporated with the College and the Medical School buildings were erected. The work went on continuously. The age for admission was raised from fourteen to sixteen. Those who wished to obtain degrees sat for the London University examinations, which had been opened to all candidates whether they had received academic training or not. But the position was felt to be unsatisfactory, and a movement was set on foot, headed by H. E. Roscoe, A. W. Ward, J. E. Morgan and Dr. Greenwood, then Principal, to obtain a Royal Charter incorporating the College as a University with the power of granting its own degrees. Opposition came from Leeds, where the Yorkshire College of Science, which has now developed into the University of Leeds, had for some time been working successfully, and also from Liverpool. The result was the grant of a Charter to the "Victoria University," having its seat in Manchester, with provisions as to the admission of colleges in other places. Liverpool and Leeds were soon afterwards included in one degree-giving body.

A New Charter Granted.

The nature of the instruction given and the character of the teaching staffs of the colleges were not changed, but the recognition thus given no doubt aided the development of all. Each college continued to do its own work, but the regulations as to degrees and the conduct of examinations were entrusted to a federal body which worked well on the whole for many years. Good accounts of the foundation and growth of the College will be found in a "History of Owens College" by the late Alderman Joseph Thompson, a member of the Council for many years and sometime Chairman, and also in an admirable statement prepared for the College Jubilee in 1901 by Mr. P. J. (now Sir Philip) Hartog, to which everyone who wishes really to understand the position and work of the Manchester College at that time should refer. Even before 1900, however, a strong local feeling arose in Liverpool that the position of that city and its college in the University was unsatisfactory and that Liverpool should have a separate university of its own. To maintain the

federal University in face of this feeling became impossible, and many people in Manchester, including influential members of the teaching staff, also desired a change which should give greater freedom of action. After some controversy, a strong judicial committee of the Privy Council decided, in 1902, that new charters should be granted. It would take too long to set out in detail the steps then taken and the actual results obtained Those who desire to know how the existing charters came into existence and how the present position was brought about will find the facts stated, I believe, for the first time, in Chapter IX, Section 4, of my recently published book "Penultima."

What was done in 1902-3 was not to found a new university in Manchester; neither the character of the teaching nor the position of the staff was changed. The old corporate body was continued and the old graduates, whether they had come from Manchester, Liverpool or Leeds, remained members of it. The new Charter, in fact, states that "The Victoria University constituted by the Charters of Her late Majesty should thereafter be called and known as the 'Victoria University of Manchester,' and shall *remain* and *continue* one body politic." Shortly after, an Act of Parliament was passed incorporating the Owens College with the University and transferring all the property of the College to it. No doubt, the result of the change, nearly thirty years ago, has been on the whole beneficial to Manchester and Leeds as well as to Liverpool. The charters give to women the same rights and status as men in the University. This is, perhaps, the most important departure from the provisions laid down by John Owens.

The University Buildings.

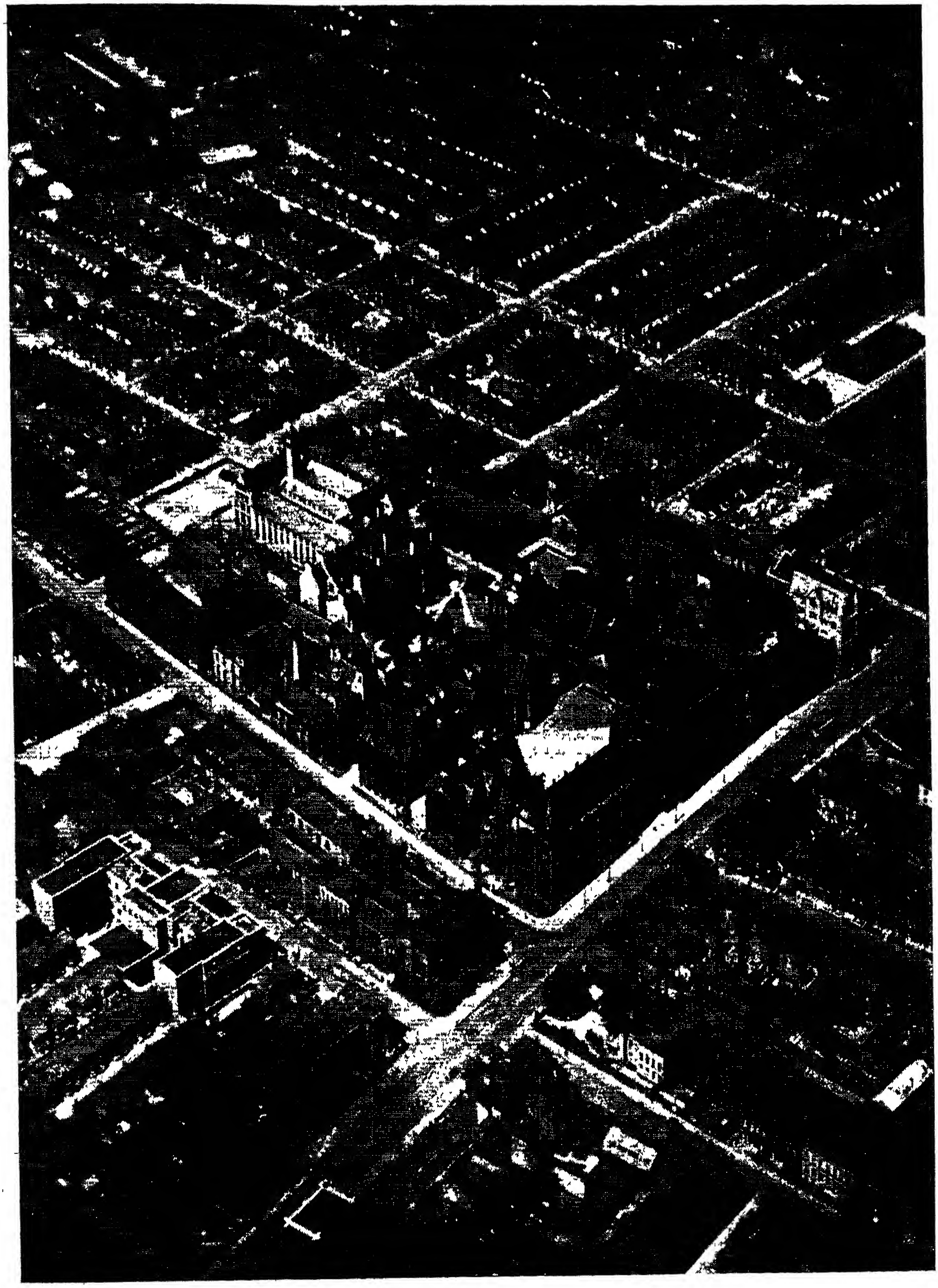
The most important buildings now belonging to the University are the main block in Oxford Street, which includes the main college building opened in 1873, the Beyer Laboratories for Natural History, the Manchester Museum, the Whitworth Hall and the Christie Library. At the back are the Chemical laboratories, the Medical School and the Botanical Laboratory The Engineering and Physical laboratories are across a street (now closed) on the north side of the old site, while the new Arts buildings, the Students' Unions and the gymnasium are beyond another street on the south, and the Public Health Department is a quarter of a mile away. Definite provision for practical instruction in medicine and surgery is made in the Royal Infirmary, which is quite near, and for gynaecology and obstetrics in the St. Mary's Hospitals. The work of the Faculty of Technology is carried on in the elaborately-equipped Technical School erected by and belonging to the City Corporation.

On 1st November last year the number of students enrolled for the session was 2,581, of whom 664 were women. In the Faculty of Medicine there were 649. Of the total number of students 781 came from Manchester and the suburbs, others from various parts of the United Kingdom and all parts of the world; 59 were from India. It would be wrong, therefore, to regard the University as being simply a "civic" university. It has strong local associations and enjoys support from the City and other local authorities in the district, but is free both from municipal and state control, though deriving the great and increasing financial assistance both from local authorities and the Treasury, and recognizing that without this assistance its work could not now be effectively carried on or developed.

An Example Set by Manchester.

The example set in Manchester no doubt acted as a stimulus to the foundation of the university colleges in other large towns, and six of these have since received university charters. Within about ten years, between 1871 and 1881—the period in effect between the removal of Owens College to its present site and the grant of the first University charter—the increasingly active interest taken in higher education was shown by the establishment in Newcastle of the Armstrong College in 1871, which now forms the home of the Science Faculty of Durham University, followed by the foundation of the Yorkshire College of Science in Leeds in 1874, the Mason College in Birmingham in 1875, the University College in Bristol in 1876, the Firth College in Sheffield in 1879, and the University College in Liverpool and the University College in Nottingham in 1881. Since that date, university colleges have been established in Reading, Southampton and Exeter. At first, special stress was in most places laid on the science side in some cases to the exclusion of arts subjects. In Wales the university college movement was marked by the foundation of the Aberystwyth College in 1872, and the Colleges at Bangor and Cardiff in 1883. All are now included in the Federal University of Wales. They appeal specially to strong national feeling in Wales, but in many respects resemble the colleges in the North of England and the Midlands.

The fact that the special eminence of certain teachers and the special facilities given for certain studies drew many students from a distance led to the establishment of halls of residence. This was essential for the welfare of students who could not reside in their own homes, and effectively promoted real social



MANCHESTER UNIVERSITY FROM THE AIR

life in the Colleges. Manchester now possesses several such halls, the earliest and largest being the Dalton Hall, made possible by the action of the Society of Friends, the Hulme Hall for men, erected with the help of funds derived from an old Trust, and the attractive and growing Ashburne House for women. The University also possesses spacious playing fields.

It has been a marked feature of Owens College and the University in Manchester from the outset that teaching and research must go together. The spirit which leads to the undertaking of valuable original research and to effective teaching being given to students is usually found in the same persons, but it is not invariably the case. The so-called provincial universities show a splendid record both of original work and of successful teaching. It is sufficient barely to indicate how wide its range has been by merely enumerating a few names out of many who have been members of the teaching staff in Manchester, such as Balfour Stewart, Arthur Schuster, Ernest Rutherford and William Bragg, junior, in physics; Frankland, Roscoe, Schorlemmer, H. B. Dixon, W. H. Perkin and C. Weizmann in chemistry; W. C. Williamson, Boyd Dawkins and T. H. Holland in geology and palaeontology; Jevons, Adamson, Alexander, Chapman and Unwin in philosophy and economics. The list might be almost indefinitely extended if names on the arts side, especially in history, were added. The school of historical study, with which the names of A. W. Ward and T. F. Tout were specially associated, has produced important contributions to knowledge and has trained a number of devoted historical students.

Extensive Activities.

The activities of a university in a large city such as Manchester are not confined to its primary duties, first, of training its own students to be fit to serve in Church and State in the widest sense of both terms and incidentally to earn their own living; and, secondly, of adding to knowledge. They may also be extended so as to exercise a useful and stimulating influence on the intellectual life of the districts in which they are placed. The extent and importance of the "extra-mural" work of Manchester University may be gathered from the Vice-Chancellor's statement in his report for the session 1928-29 that forty-nine tutorial classes had been held in the city and many of the large towns in East Lancashire, that with the help of the Carnegie Trust the Central Library for external students was rendering constant service, that twelve university extension courses were given either in the University or at centres outside Manchester, and that, under a scheme of co-operation with the Education Committees of the Lancashire and Cheshire County Councils, many lectures had been provided for teachers and the public.

Lectures, demonstrations, and other educational work done in the Museum, which is included among the University buildings, show encouraging results. Children from elementary schools regularly visit the Museum under proper guidance. Perhaps most valuable of all is the co-operation between the University and the magnificent Rylands Library in affording opportunities for advanced study, both to members of the University and to scholars from a distance, as well as in providing public lectures, many of which are original contributions of highly valuable knowledge. Mrs. Rylands from the outset attached great importance to this close co-operation.

The University Press.

It is impossible to mention all the extra-mural service rendered, but the work done by the University Press cannot be omitted. In many respects it is similar to that conducted on a larger scale by the Clarendon Press at Oxford and the Pitt Press at Cambridge. It secures the publication of learned works which might otherwise be lost, and also of information relating to the University of special interest to its members. Co-operation with other institutions engaged in educational work in the widest sense has been the keynote of the policy of the University.

Lastly, under the provisions of the Charters of the Northern Universities, a Joint Matriculation Board conducts and controls the Matriculation examination required for candidates in all the Faculties or in any of them. This examination is accepted by most professional bodies, and thus has the advantage of avoiding the inconvenience of duplicating examinations and also of maintaining a uniform and high standard for those who are entering on courses for degrees.

The Charter provides that, for all the other examinations, at least one external and independent examiner shall be appointed "for each subject or group of subjects required for university degrees." While aiming at complete independence for the new universities in teaching and in developing on the lines each finds desirable, it was felt that some safeguards were required to secure the maintenance of a uniformly high standard for all. This is specially important in the case of degrees in medicine which confer the right to practice. The Colleges have gained the right "to brand their own herrings," and it is the interest of all to maintain the value of the brand.

Recent Discoveries in Archaeology.

So many important discoveries are recorded in archaeology that it is possible to deal with only a few of them in full-length articles. These notes will be followed by others in which outstanding topics are discussed.

Distribution of Early Man.

In the October issue of *Discovery* (p. 346), reference was made to Mr. Leakey's investigations in the prehistory of East Africa, which go to show that the stone-age cultures of Kenya are to be grouped in relation to pluviations, and that the character and relation of the geological deposits point to two major periods of heavy rainfall in prehistoric times. It is suggested further by Mr. Leakey that these two pluvial periods are to be correlated with the glacial epochs of the Pleistocene age in Europe. The question of the relation of glacial and pluvial periods in prehistoric times was also the subject of a joint discussion between the anthropological, geological and geographical sections at the Bristol meeting of the British Association, in which a number of workers from various parts of the world took part. Geological evidence was adduced from the Faiyum (Misses Gardiner and Caton-Thompson), South Africa (Mr. Leslie Armstrong), India (Mr. L. A. Cammiade), Palestine (Miss Garrod), and China (Professor G. Barbour), in support of the view that two pluvial periods had occurred in each of these areas which might reasonably be equated with the pluvial periods of East Africa and correlated with the glaciations of Europe in the Pleistocene age, one falling early, between the Gunz and Mindel glaciations, the later between the Riss and Würm epochs of maximum spread of ice.

In this connexion attention may be called to an interesting article in *Antiquity* for September, in which Mr. Miles C. Burkitt and Mr. L. A. Cammiade deal with the evidence bearing upon the stone-age in South-east India afforded by the laterite of the Coromandel coast and the Eastern Ghats. The laterite, which is a composite deposit formed from the detritus of various rocks and requires a heavy precipitation for its formation, provides evidence of two pluvial periods with an arid period intervening. Four stone-age cultures are distinguished which are brought into relation with the climatic changes shown by the laterite. Of these cultures the first is marked by the occurrence of large stone hand-axes of a type similar to that found in Africa, and especially at Victoria West in South Africa. In commenting on the relations of the remaining three cultures to those of Africa, the authors suggest, in view of the linking up of stone-age cultures from South Africa to Palestine, that India may be on the periphery of an area of distribution of Upper Palaeolithic man.

A Philippines Discovery.

Evidence bearing upon the distribution of early man from various parts of the Old World grows steadily, and suggests that we may be on the eve of a momentous extension of our knowledge of the early phases of man's history. Palaeolithic implements which the geological evidence assigned to the quaternary age were discovered in China only a few years ago, and now news is to hand of an important discovery in the Philippine Islands. During the last three years investigations on and near a village- and cemetery-site on the banks of one of the rivers has produced an enormous number —some thousands—of archaeological specimens of varied age. Among these are a large number of stone implements, some of which are said to be, possibly, Mousterian. Until further and more precise details are to hand judgment must be suspended; but the find would seem to be of first-rate importance.

The Peking Skulls.

Professor Elliot Smith, who is now in China, would appear to have been still further impressed by the importance of the Peking Man skulls after having had an opportunity of handling the actual specimens. The second skull, which was found last July in material which had been removed from the cave of Chou-Kou-Tien in the previous October, belongs to the same type as the skull found in December, but differs from it in certain details. The bone is thinner. Dr. Davidson Black is, therefore, of the opinion that the skull found in December is that of an adolescent female while the second is that of a young adult male. In his report on the first skull, after it has been sufficiently cleared of the matrix to permit of something like a detailed examination, he is of the opinion that Peking Man represents a forerunner or ancestor of Neanderthal man—a proto-Neanderthal type. On the other hand, Dr. Hrdlička of Washington, one of our foremost authorities on the skeletal remains of early man, has recently expressed the view that Peking Man is a member of the Neanderthal group.

Interpreting the Secrets of the Jungle.

By G. A. C. Herklots, B.Sc., Ph.D., F.L.S.

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A full appreciation of the unusual beauty which is peculiar to the jungle calls for the eye of an artist, the ear of a musician, and the sensitive touch of a craftsman, but a study of the plant life of the Malayan rain-forests, with which this article mainly deals, amply repays the observant botanist.

When visiting a place for the first time, be it oriental town or coral reef, one reacts to the new surroundings and forms mental "first impressions" of the scene. These impressions quickly leave one's memory and, unless notes are committed to paper immediately, the vision fades and is rarely recalled, except, as it were, through spectacles fogged with the facts and theories read in books or discussed by others The most vivid impression of a first visit to the jungle is the all-embracing silence and stillness, yet the jungle, though silent, is full of sound, though still, is full of movement. Those who have read about the rain-forest, and have seen pictures of it, are profoundly disappointed on entering the jungle for the first time. But coming to the untamed wilds from the civilized world, where man is dominant, requires a tuning of the senses, a quickening of response to sound and smell, a greater delicacy of touch.

First Impressions.

All seems at first to be a drab blur of browns and dull greens, but the observant visitor sees colours before undreamed of, unsullied as though reflected from a rainbow. To appreciate the jungle fully one needs the eye of the artist, the sensitive touch of the craftsman and the ear of the musician. A little scientific knowledge is an aid in the interpretation of jungle secrets; here a millipede, a vegetarian, is enjoying a meal; there a carnivorous centipede is on the war path; snakes and scorpions, fantastic spiders and noisy cicadas all are to be seen if the eye is bright to catch a strange glitter as of gold and the ear is keen to descry the rustle of a leaf.

I had the good fortune to spend five weeks this year in the Malay Peninsula. For the first fortnight the Botanic Gardens, Singapore, were my base, but the remaining three weeks were spent actually in the jungle. These three weeks included a few days on Fraser's Hill, four thousand feet high, on the borders of Selangor and Pahang, and a little more than a fortnight in the Federated Malay State of Negri Sembilan. From Singapore, I visited both mangrove swamps on the island and also the forest covered mountain, Gulong Panti, in Johore, which is seventeen hundred feet in height. So I have seen, if only cursorily, varying types of jungle, from sea-level to a height of four thousand feet. The fortnight in Negri Sembilan was spent in the company of an officer from the Botanic Gardens, and constituted an expedition in so far as we went with the definite object of studying and collecting fungi. Though termed an expedition, our wanderings were never far from the beaten track and we neither camped out nor took with us an army of camp followers; a fortnight only at our disposal was insufficient time to be worth the trouble involved in carrying tents and food, and cutting our way through the jungle to an unknown peak. We therefore stayed for several days at a time at three of the numerous rest-houses dotted about the State, and each day, accompanied by native forest-guards, or coolies, we visited one or other tract of forest-reserve or untouched jungle.

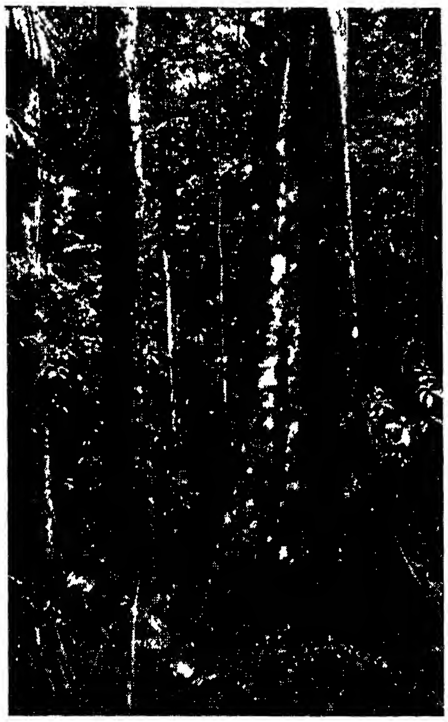
Our wanderings in the jungle were not exciting in the usually accepted sense; we met no elephant, heard no tiger, and disturbed no rhinoceros or wild boar; but jungle is always of fascinating interest, and one is never certain whether a panther may be on the bough overhead, watching intently with eager eye, or whether a python is lying in wait behind a coiled liane, ready to strike at the slightest provocation. Of course, it is impossible to spend much time in virgin jungle without seeing evidence of wild animals, unless the botanist is so keen on his quest that he neglects the zoological side completely.

Unknown Land.

There are 37,000 square miles of forest in Malaya, nearly three-quarters of the area of the country, and the greater portion of this is unknown and unexplored. Here an adventurous botanist has scaled a peak in search of orchids or other plants; he departs, and in a few weeks, the rapidly growing vegetation has obliterated his tracks; or perhaps a forestry officer has roughly surveyed a tract in

search of easily portable timber. But the greater portion remains unknown land, the home of the elephant, seladang, and carnivore.

Special clothing and equipment is, of course, required for jungle work. Clothes must be tick- and as leech-proof as possible; they must be strong enough to withstand the barbs of rattan and the spines of certain palms and lianes, and must be sufficiently porous to let out the water that will inevitably find its way in. A coat is a nuisance. A khaki shirt with short sleeves and khaki trousers tone well with the surroundings and do not make too evident the mud that will soon bespatter them. Canvas boots with studded soles and puttees, well wrapped round the ankles and calves, will discourage the most blood-thirsty parasites. A parang with horn or bone handle and a sharp twelve-inch blade of steel, a camera and stand, a vasculum for the spoil, and an old topee the best protection for the head, complete the equipment. A coolie per man, to help with the specimens and the chopping, is a great aid since it enables one to be freer to examine objects of botanical or of photographic interest.



BUTTRESS ROOTS.

The reason for the origin of the huge buttress roots which the giant jungle trees develop is still obscure.

Early one morning we climbed into a ricketty old car, piled our baggage on the floor in front of us and drove off. Near the edge of the village we picked up a couple of Malay forest-guards, and so proceeded, rattling and creaking up the pass. The road meandered along between fields of newly planted paddy, clumps of dark green sago palms and groups of native attap huts. Presently, we ascended a still more tortuous route. Here by the roadside a giant tree stood solitary, a reminder of the days when all around was the untouched wild We drove along the edge of the forest and now could observe the characteristic plants which grow where there is abundant light and moisture, and which are never found in the dense shade of the jungle. The banks are covered with the rank growth of *Gleichenia* ferns, and the intricate tracery of the dichotomously branching fronds leave a permanent impression on the memory. Higher up, we noticed an abundance of *Melastomaceous* shrubs with their pink flowers. The colour of the flowers is not very pleasing, neither are the plants particularly graceful. Here was a depression in the ground sodden with water which had percolated through the bank above. Rooted there was a plant of the beautiful flowering climber, *Bauhinea flamifera*, and looking up into the trees flanking the road we could see the sprays of brightly coloured flowers. Bauhineas, typically, have partially or completely bifid leaves; when the leaf is young it is folded so that the two lobes press closely against each other, and hence the Chinese have given them a name meaning "friendly leaved tree." In Malaya, most of the bauhineas are climbers and this species, with flowers yellow on opening and changing later to an orange-vermillion, is abundant in damp places on the edge of the jungle. They do not flourish, however, in the dense shade cast by the giant trees within the forest boundary.

We left the ancient car to be doctored by the "sais" and, accompanied by the forest-guards, entered the forest. Following a path it was rarely necessary to use our parangs, and we were thus able to look around us and to note the spiders on their webs, the fungi, giant polypores, sticking horizontally like brackets from the trunk of some dead tree, and the red *boletus* and pearly-white *amanita* breaking through the leaves carpetting the floor. The particular tract we visited was a forest reserve which had been alienated for some years, and we were particularly interested to observe the methods adopted to conserve the area. The simplicity of the scheme employed is striking. The large timber trees are graded into first and second classes, and the forest-guards are taught to distinguish the species in the two groups by their leaves, or, if the leaves are too far out of sight to be visible, by their trunk, bark and the nature of their sap. A certain number of the first-class trees are removed for timber, but many of the giants are left to produce seeds. The second-class trees are roughly "ringed" two or three feet from the ground and left to die, the younger trees of this class being cut out with a slash of the "parang." Two results of this procedure were at once apparent to us, namely, the abundance of seedlings and saplings of the first grade and the

presence of dead second-class trees standing gaunt and naked, or prostrate on the ground, obstacles in the path to man and beast. Eventually such an area will contain trees of a certain uniformity both as regards quality and size of timber.

In this area, unusually dry at the time of our visit, we saw many interesting plants and animals. One small bush called *Thottea* had amazingly large flowers, purple and white and green; this plant is allied to the *Aristolochia*, a genus which has even more strangely shaped and coloured flask-like flowers. The spiny "Bertam" palm, a species of *Eugeissonia*, was abundant in the lower regions but, owing to the dryness, rattans were conspicuous by their almost complete absence. A few *Licuala* and *Pinanga* palms were seen, but most of the vegetation consisted of dicotyledonous trees and their seedlings. At the top of a small exposed peak, about fourteen hundred feet high, we found some plants which were much more characteristic of the exposed and arid mountain tops of South China. There were ericaceous shrubs and one of the Myrtaceae, *Baeckea frutescens*, with fragrant aromatic leaves, which is so abundant in Hongkong.

A GIANT TREE.

Photographing giant trees is difficult, since it is usually necessary to be at least two hundred yards away.

Lower down in the reserve some quaintly shaped and brightly coloured spiders attracted my gaze, and I managed to collect and preserve a couple for future examination. Fungi we found in abundance, especially in the lower and damper regions, and these included many species of interest which we collected or photographed.

Photography in the tropics is no idle hobby, and unless it is pursued methodically and scientifically, the results are usually only fit for the rubbish heap. Both my friend and I took with us double extension cameras with good lenses and shutters, and a stand. We used panchromatic plates and colour filters, and gave long exposures. My photographic experience in Hongkong was of little value, conditions being very different in Malayan jungles, but my friend had experimented considerably and had both systematically recorded his results and classified them. Using his experience as a basis, and recording the details of every exposure, we succeeded in taking a series of excellent photographs. Exposed plates must not remain long undeveloped in the tropics, so on alternate evenings we developed our plates in a tank, using a standard technique, and fixed and hardened them in a special fluid immediately afterwards. When the plates had been washed and dried they were carefully examined through a lens and, if the exposure was thought to have been incorrect, a note was made of the exposure that should have been given. As a result of this somewhat elaborate checking of results, by the end of our expedition we rarely exposed a plate in vain; that these precautions were necessary is illustrated by the fact that the exposures I gave varied between 1/25th second with a filter to seven minutes using no filter.

Another drawback in photographing the jungle, in addition to the great variation in light intensity, is the difficulty of obtaining sufficient space between object and lens so as to be able to include the whole object in the field of view. This difficulty cannot be overcome in the case of giant trees, since one has often to be two hundred yards from the tree in order to photograph it; giants must be photographed at the edge of a forest clearing. In the case of smaller plants, sometimes three-quarters of an hour's hard chopping with a parang is necessary to clear away intervening saplings and gingers, and this procedure we were compelled to adopt almost invariably in the thick jungle.

On Gunong Angsi, 2,709 feet high, the forest is still virgin, and except for two winding paths—the Sereban Road from the Kuala Pilah and a path from Perhentian Tinggi, both leading to the rest-house near the summit—the place is untrodden by the foot of man. In forests, frequently the man-made paths closely follow the tracks of elephants or other big game. It is therefore unwise to camp on or near a track lest elephants wander along in the night and hurl the camper, his coolies and equipment into the nearest bush. The converse also frequently holds good—that animals make use of man's paths especially if little used by man himself. On the few paths on Gunong Angsi we invariably found fresh tracks of

tapir, but we never saw one of these very shy and wary animals. In one forest, we found an interesting fungus, growing on elephant dung on the path, and collected a specimen. On another day, my friend found a large and magnificent mushroom, which, with difficulty, I carried back intact to the bungalow. " Very good to eat " we told our Malay assistant, but he only smiled and shook his head. He was correct; the flavour of the mushroom was disappointing and not in the least what we had been given to expect by the fragrance of the smell.

There are several things, other than camping on elephant tracks, which it is inadvisable to do in the jungle, and these one discovers gradually as a result of experiences which are not always pleasant. One day in lowland jungle, while my friend was photographing a clump of fungi, I sat down on the path to take a well-earned rest Presently, I noticed at the bottom of one of my puttees what I took to be a small brown worm. Idly I wondered how it had got there and what it was doing. Later, it began to walk up my leg in the manner of a looper caterpillar, which I momentarily thought it was until it dawned on me that the looper was a leech. Promptly I took a tube out of my pocket and the leech became a specimen.

AN ORCHID IN DENSE JUNGLE

An important feature of the expedition was the collection of plants, among which were many beautiful orchids.

No account of jungle vegetation, however brief, is complete without some mention of the trees with the curious stilt roots and those with the even stranger buttress roots. Of course, we endeavoured to take photographs of typical specimens of both types. Occasionally one meets with a Pandanus plant with stilt roots, a long slender stem, branched perhaps at the apex, and with a crown of long drooping narrow leaves evilly toothed at the edges. It is no light task to clear a space round one of these plants, in order to take a photo of the stilt roots, attenuated trunk and crown. Other trees with stilt roots are the figs; one frequently meets with such a tree in the jungle and they make interesting photographs. These stilt, or prop, roots of *Pandanus* and *Ficus* are very different from the buttress roots which are developed at the base of many *Dipterocarpus*, *Artocarpus*, and other species of *Ficus* trees. Buttress roots resemble thick planks and are often four or five feet in height at the trunk, sometimes sloping very steeply to the ground at a distance of four or six feet, and at other times tapering gradually. In these cases, the roots are often sinuous and, if a tree develops several, they give it a very uncanny appearance. The reason for the origin of these roots is still obscure, but it is significant that, when trees of these genera are found growing on steep banks, they generally possess well developed buttresses.

One of the most enjoyable glimpses of the jungle's varied life is obtained in the evening. A walk along a jungle path, silently and preferably alone, an hour or so before sunset, reveals a wealth of life whose presence was unsuspected an hour earlier. The cicadas have not yet begun their deafening evening chorus, and thus it is possible to hear distinctly the cries and calls of other animals. In the moist valley below, the grating cry of frog or toad pierces the silence of the forest, and is repeated at regular intervals. A bird is heard, is silent for a minute, then calls again. Both these two cries of frog and bird can be imitated to perfection after a little practice. In the distance, a glimpse is obtained of a gibbon in the tree-tops, and faintly, from still further away, comes the curious whistling cry of another This monkey whistles the whole scale, slurring two or three notes at a time, and then, having reached the top note and unable to descend the scale but keen to try, starts in the middle, slips down two or three notes, and finally abandons the attempt. A night-jar, on a branch of a tree in the valley below, imitates the clucking of a domestic hen.

Clouds are gathering from the plains below and soon the mountain-top is enshrouded in mist. As I walk back to the rest-house I can see in the distance the dancing flames of a forest fire, where secondary jungle is being burnt preparatory to rubber planting There is much to be done before bed-time: the day's collection of fungi, mosses, and orchids to be sorted out and examined, negatives to be developed, and notes of the day's experiences to be entered in my diary.

When Wheels Revolve the Wrong Way.

By V. H. L. Searle, M.Sc.

Lecturer in Physics at the University College of the South-West of England.

Why is it that the wheels of a moving vehicle often appear to be moving in the wrong direction when shown on the cinema screen? The stroboscopic method of examination, which is here described, permits a study of this and similar effects of high speed, and enables engineering methods to be tested.

A RATHER curious effect can sometimes be seen in a cinematograph picture showing a moving vehicle the wheels of which have large spokes. When the vehicle is travelling at a good rate the spokes cannot be seen, but when the car or carriage slows up they come into view, and it is at such times that the effect mentioned occurs. Instead of moving round in the correct direction for the motion of the car they seem to go at first rapidly and then more slowly in the wrong direction. Then they come momentarily to rest before beginning to move in the correct way. This is rather confusing, and gives the impression that the car is in reverse with the wheels skidding, except that the driver appears unconscious of the remarkable experience.

Illusions of the Cinema.

This is only one example of the illusions which occur frequently when the cinema camera—operated at the usual speed—takes pictures of rapidly moving objects, and which are due to the fact that a continuous record is not really obtained but only a quick succession of snapshots. Suppose, for example, a cinematograph camera, taking sixteen pictures each second, is photographing a revolving disc upon which is painted a black arrow on a white background, and that this disc is rotating 954 times per minute, that is, 15.9 revolutions each second. The first snapshot would give the result shown in Fig. 1 (*a*). One-sixteenth of a second later the next exposure is made, but in this time the disc has not quite completed its rotation, and therefore is in the position shown at (*b*). The third picture is shown at (*c*) and so on. On presentation upon the screen, these would follow one another at a rate of sixteen pictures per second in the sequence (*a*), (*b*), (*c*), and persistence of vision would merge them into an apparently continuous view of the arrow revolving backwards at a rate of one rotation in ten seconds. If the disc were speeded up to sixteen turns per second, it would appear stationary, while at a rate of 16.1 revolutions each second it would have an apparent rate of advance of one complete rotation in ten seconds. During the slowing up of the wheels of a car, this speed of synchronism is passed through more than once—it will be realized that, if one spoke moves, between exposures, forward to the place previously occupied by the next one, the stationary appearance results—with the effect already described. By regulating the speed of the disc in the experiment outlined above, it will be possible to give it any apparent speed either forwards or backwards, and the consequent slowed-up effect is known as a stroboscopic view.

This must not be confused with the somewhat similar "slow-motion" pictures. To produce these, the camera is made to work at six or seven times its usual speed, so as to take, say, one hundred pictures every second. These are then projected at the standard rate of sixteen per second, and thus all movements are correspondingly slowed to one-sixth of their real speed, enabling details such as the action of an athlete in a sprint race, the finger movements of a conjurer, or the wonderful repetitive motions of a juggler to be studied. There is a reverse process in cinematography—the taking of successive pictures at long intervals with a consequent impression, on presentation, of a great acceleration in the process photographed. This is used for such things as the progress of a plant from seedling to full growth, or the unfolding of a bud into the complete bloom and its subsequent transformation into fruit.

The Stroboscope.

The stroboscopic method of slowing up rapid motion does not necessarily involve the cinematograph at all, and it is a commonplace in the laboratory or the engineering research room. All that is essential is a succession of views of the object to be studied at a rate which differs slightly from that at which the body performs its cyclic movements. Preferably, the time between successive glimpses should be rather longer than the time for one complete movement of the body studied, since in that case the motion will appear to go on, at a much slower rate, in the correct direction, whereas, if the body is rotating or vibrating

more slowly than the frequency of the successive views given by the stroboscopic apparatus, it would appear to go backwards. In any case, for realism, the pictures must follow one another at a rate rather in excess of ten per second, so that the persistence of vision may produce the useful impression of continuity.

The special method used to produce the stroboscopic result will be decided by the circumstances of the particular observation to be made. One common application is the determination of the number of vibrations made each second by a tuning fork, *i.e.*, its frequency. For this, the tuning fork is fitted with two small and light pieces of metal, one on each prong, so that, when the fork is not vibrating, the edges of these come together closing the space between the prongs as shown in Fig. 2 (*a*), where *A* and *B* are the prongs—seen on end—and *C*, *D* are the metal vanes. The fork *F*, Fig. 2 (*b*), is then placed in front of a large circular disc which carries a number of regularly spaced holes *H* and behind the disc, in line with the prong ends, is an electric lamp. If there were always an opening between *C* and *D* and the disc revolved, light from the lamp would shine through each hole as it came opposite the lamp and thus a flicker of illumination would be seen if the frequency of the disc were small, but the flicker would change into a uniform illumination for a rapid rotation. On the other hand, with the disc stationary and the fork vibrating, light could get through only once per vibration. This again would, owing to the persistence of vision, give rise to an apparently continuous admission of light. Suppose, now, that the fork vibrates and the disc revolves. Every time the fork prongs separate there is an opportunity for light to come through, but it can do so only if one of the holes is behind the gap. Therefore, for continuous illumination the disc must revolve at such a speed as to place a hole behind the prongs every time they open. The lowest speed at which this will occur is when the product of the number of holes and revolutions of the disc per second equals the frequency of the tuning fork. In practice a microscope or low-power telescope is directed at the gap between *C* and *D* and, for this correct speed of the disc, the illuminated hole is seen apparently stationary. A slight change in the rotation rate makes the hole move slowly—backward for a slowing up of the disc and forward for an acceleration. Thus, to find the frequency of the fork the disc, which is driven by an electric motor, is gradually speeded up from rest and a revolution counter gives its rate of rotation. This is noted when the holes first appear to be stationary and then multiplied by the number of holes. This procedure is necessary because if the disc were travelling at twice or three times this speed the same appearance would result; in the first case every alternate hole would be seen at the same place and, in the second, every third hole.

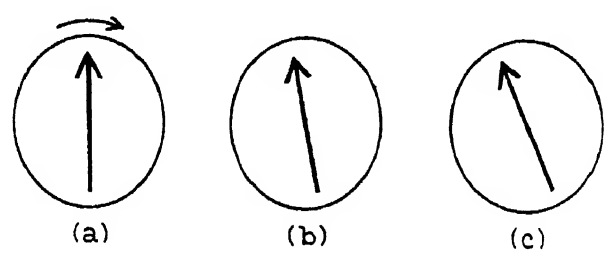


Fig. 1.

If a cinematograph camera were to take a picture of an arrow revolving clock-wise, in the first three exposures the arrow would appear in the positions shown above. Presentation on the screen, however, would show an apparently continuous view of the arrow revolving backwards.

The tuning fork is kept vibrating throughout the experiment by means of an electric battery *E*, which is connected to the base of the fork, and also to a platinum tipped screw *S* which nearly touches a contact *T* fixed to the prong of the fork. From *T* the wire passes round an electromagnet *M* and then back to the base of the fork. If the fork is now tapped, the lower prong moves down, the contact between *T* and *S* is established, and the current flows. This magnetizes the electromagnet, which therefore attracts both the prongs back again with a consequent breaking of the *TS* contact. The current ceases, the magnetism stops, the inward pull on the prongs disappears, and they fly out again to go over the same cycle once more. Thus the fork continues to vibrate as long as the battery is joined in and has enough energy to work the electromagnet.

This is not the most accurate method of measuring the fork frequency. For example, a small mirror may be fitted to the fork prong and thus cause a vibrating spot of light to move transversely across a rapidly moving cinematograph film. This produces a wavy trace of which one wave corresponds to a complete vibration of the fork. If, in addition, another spot of light is moved over the film by means of a second mirror fixed to the pendulum of an accurate clock, it is comparatively simple to count, on the developed film, the actual number of vibrations made by the fork in one second. It follows, therefore, that the stroboscopic experiment is more exact when used in the reverse order, that is, to use the accurately known frequency of the tuning fork as a revolution counter. To do this, the moving mechanism to be regulated at a fixed speed is examined through the prong gap and adjusted until

it appears always stationary. A very slight change in the speed will then cause a slow apparent movement in the mechanism.

There are disadvantages in this method. In the first place, it is not easy to know if the speed for the stationary position is equal to one, two, three, or more times the speed of the fork, and, secondly, the measurement applies only to these special rates. To avoid these difficulties, a variation of the experiment may be adopted in which a viewing disc is used. This is attached to the body whose speed is to be measured, and which carries a series of geometrical figures such as a thirty-pointed star, a hexagon, a pentagon and a square. Certain figures will be seen to be motionless for one speed, others for a different speed, and so on. For example, at a rate corresponding to five-twelfths of the frequency of the fork, the thirty-pointed star is seen doubled—*i.e.*, with sixty points—the hexagon also is doubled, while the square is tripled. Thus, by observing the appearance of the stationary figures—the others being, of course, blurred—a large variety of speeds can be measured and, if necessary, kept uniform, while small changes from these can be measured and adjusted by noting the rate at which the consequent slow motion goes on.

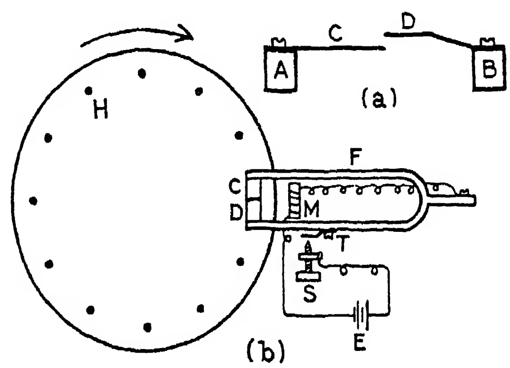


FIG 2

A common application of the stroboscope is the determination of the number of vibrations made each second by a tuning fork, fitted with two pieces of metal shown at C and D.

Continued observation through the gap of the forks is not easy, and so, to make the experiment more comfortable and convenient, this gap method of viewing is replaced by a flashing light. Suppose the tuning fork as it vibrates is made to actuate a second pair of platinum contacts and thus to cause an intermittent current to flow in a second circuit. This current, entering a transformer, produces a correspondingly changing high voltage which is applied to a neon lamp. The lamp then flashes once for each vibration of the fork, and these rapid bursts of illumination give sufficient light to illuminate the disc. It will be realized that any special appearance seen through the fork gap will now be obtained from any point of view, since the stroboscopic illumination is obtained by the intermittence of the light itself instead of being caused by the interruption, by the fork, of the steady light from an electric lamp.

Another experiment which can easily be fitted up to demonstrate stroboscopic vision concerns ripples on the surface of a pool of mercury. If the screw S of Fig. 2 (*b*) is replaced by a pool of mercury, and the contact T by a platinum wire fixed to the fork prong and projecting downwards, electrical contact will be made every time the wire dips into the mercury. The consequent agitation of the liquid surface causes a series of ripples to spread continuously from the point of disturbance. They travel too rapidly to be directly observable, but every time the wire leaves the mercury a small but brilliant spark occurs. These sparks will have the same frequency as the fork, and they will thus occur when the newly formed ripples are in a particular position. Therefore the wavelets appear stationary, their formation can be studied in detail, and, from a measurement of their wave-length or distance from crest to crest, the important quantity known as the surface tension can be calculated. A similar observation may be made on the ripples produced in different liquids by using a neon lamp as illuminant.

An accurate measurement, and check on the constancy, of the alternating mains frequency can be made by means of a tuning fork and a neon lamp. The lamp, when placed into an ordinary bulb socket, flashes with the same number of cycles as that of the supply. This is usually stated to be fifty per second. Now suppose the lamp illuminates an electrically maintained 50-cycle tuning fork. It ought to appear to be motionless, but it will generally be seen going slowly through its vibration. This shows a divergence between the two frequencies and, since that of the fork can be obtained accurately, that of the mains can be calculated. If, for instance, the fork is seen to make one complete movement in five seconds, then the mains will have completed either 249 or 251 cycles in the same time or their frequency is either 49.8 or 50.2. To decide between these possibilities the fork may be lightly loaded or touched. This will slow down its motion slightly and will bring it more nearly into unison with the mains if their frequency is 49.8. Thus, if the light load on the prongs causes the apparent motion to be slowed up still more, then 49.8 is the correct mains frequency. Usually the electric supply alternations are not quite constant, and therefore the apparent motion of the fork will occur at varying speeds. By repeating the observations to cover the quickest and slowest of these, the range of mains frequencies will be known.

In engineering practice, it is the slow motion property of stroboscopic vision which is most useful since this allows machinery to be examined when it is moving at a rate which precludes observation by other means, and it will be appreciated that effects may appear at high speeds which are absent at lower rates of motion. For example, the valves of a motor-car or motor-cycle engine are made to move up and down by being pushed up by tappets which are operated through cams on the camshaft, and returned to their seatings under the action of the valve springs, which have been compressed by the rising tappets The quickness of this return depends on the speed with which the springs can relax when the pressure on them is removed, and, at high speeds, there may be too long a time taken in this return for the most efficient working of the engine. In addition, the valve at the end of its tappet's upward travel has a great speed, and it may thus be caused to jump out of contact. On its subsequent return, valve stem and tappet will meet with great force which may cause a rebound. These results would not occur at slower speeds, and their occurrence will decidedly affect the power generated by the engine and thus its efficiency.

Practical Tests.

The stroboscopic method of examination permits a study of these and similar effects of high speed, and also enables the utility of preventive measures to be tested. For such tests some rotating member—for instance, the camshaft—carries a toothed wheel which has, say, 99 teeth, and this engages in a second sprocket with 100 teeth. The latter carries a rotating contact so as to light a neon lamp once per revolution. This means that the camshaft has, meanwhile, made 1.01 revolutions. Thus, each view of the moving parts given by the lamp's intermittent light is one-hundredth of a cycle later than the previous one, and so the whole cyclic movement is seen to be performed at a speed one hundred times slower than its real rate. For example, if the camshaft is making 6,000 revolutions per minute, the valves, springs, and tappets are seen moving at the comparatively leisurely rate of one complete motion every second. If the two engaged wheels had 999 and 1,000 teeth respectively, the slowing up would be one thousand times.

It will be seen that the stroboscopic method of experiment is full of interest, and is sufficiently flexible for use in a wide variety of circumstances, in some cases providing an adequate, accurate, and fairly simple means of carrying out observations which cannot be made by any other direct means.

Correspondence.

BRITISH ASSOCIATION'S CENTENARY APPEAL.

To the Editor of DISCOVERY.

SIR,

The British Association for the Advancement of Science has recently concluded a most successful meeting at Bristol, at which discussion has taken place as to the arrangements for the Centenary Meeting, to be held in London, with the gracious approval of H M the King, patron of the Association, and under the Presidency of General Smuts

The Association during its first century of existence may claim to have established itself, first as a national, and more lately as an Imperial institution Its Council is of opinion that, despite the steady support which it receives from its members, and the generosity of certain individual benefactors, and of those home cities or Dominions, which from time to time entertain it for its annual meetings, the power the Association has acquired for the advancement of science might be far more effectively exercised if it possessed a larger endowment The Council would be loth to risk narrowing the present wide field of membership, and therefore of interest and usefulness, by increasing the subscription for the Annual Meeting, though that still remains at the figure of one pound at which it was fixed in 1831, and has even been recently reduced to half that sum for junior student members The Council has therefore decided to appeal for a Centenary Fund of £40,000

A first charge upon that fund or the income from it must be the expenditure appropriate to the fitting celebration of the Centenary itself In this connexion it is the object of the Council to make the Centenary Meeting an occasion for the gathering of the largest possible representative body of scientific workers from the Dominions, and by this means to repay something of the debt which the Association owes to those Dominions whose hospitality its members have enjoyed Beyond this immediate object the Association earnestly desires to maintain and extend its annual financial support of scientific research, to discharge fittingly the trusteeship of Darwin's house at Downe, recently entrusted to it in custody for the nation and indeed for the civilized world, and to assure the means of carrying out its Imperial responsibilities Its financial constitution has always forced it to live in a measure from hand to mouth

The contributions towards research from the funds of the Association fluctuate annually with its net balance of receipts over expenditure, and it is therefore often a matter of chance whether the Association is able to support any particular research in accordance with its intrinsic importance Not infrequently the Association has to count the cost, with too much appearance of parsimony, before accepting an invitation to a particular place, having regard to the prospects of local support Where the Association is summoned to carry on its public mission, there the Council feels that it should be able to go without question or limitation on financial grounds

Contributions to the Centenary Fund will be gratefully acknowledged by the General Treasurer, British Association, Burlington House, London, W 1.

We are, Sir, your obedient servants,

F. O. BOWER, *President.*

J. C STAMP, *Hon. General Treasurer.*

JOHN L MYRES, F. J M. STRATTON, *Hon General Secretaries.*

O. J. R HOWARTH, *Secretary*

Prehistoric Monsters.

The following notes describe a new series of photographs just published by Camerascopes Ltd.

UNFORTUNATELY, photography does not go back so far as the days of the diplodocus, and our only knowledge of its bulk and form is derived from the models which have been constructed so patiently from a few bones. So unwieldly are the models, however, that comparatively few are able to study them, since they cannot easily be carried about. The obvious substitute, therefore, is a photograph, and this has been carried out very successfully by an ingenious method. Landscapes have been built to conform to the scientific conception of the hunting grounds of prehistoric monsters, and a highly natural conception of the animals and their manner of living is presented. By a study of the formations of the bones of fossilized skeletons, it can be decided whether the animal was mammal, bird or reptile, and the creature's food is ascertainable by examination of the teeth. From such starting points, the body can be reconstructed. These great beasts were remarkable for their lack of brain space, and although some of them reached a length of one hundred feet, their brains were negligible.

The method of constructing the models is interesting. First, a framework of wire and metal is built, conforming roughly to the skeleton of the animal, and this is covered with some material which can be moulded by hand. The muscular system is now worked in, and when all the details are completed, a plaster cast is made. The cast, when dry, is coloured; and here an element of chance creeps in, for in very few cases have any coloured remains been found with the fossils recovered. Modern forms must be taken as guides. On the other hand, the nature of the landscape is possible from a study of the geological strata and the vegetable fossils found in the vicinity of the bones.

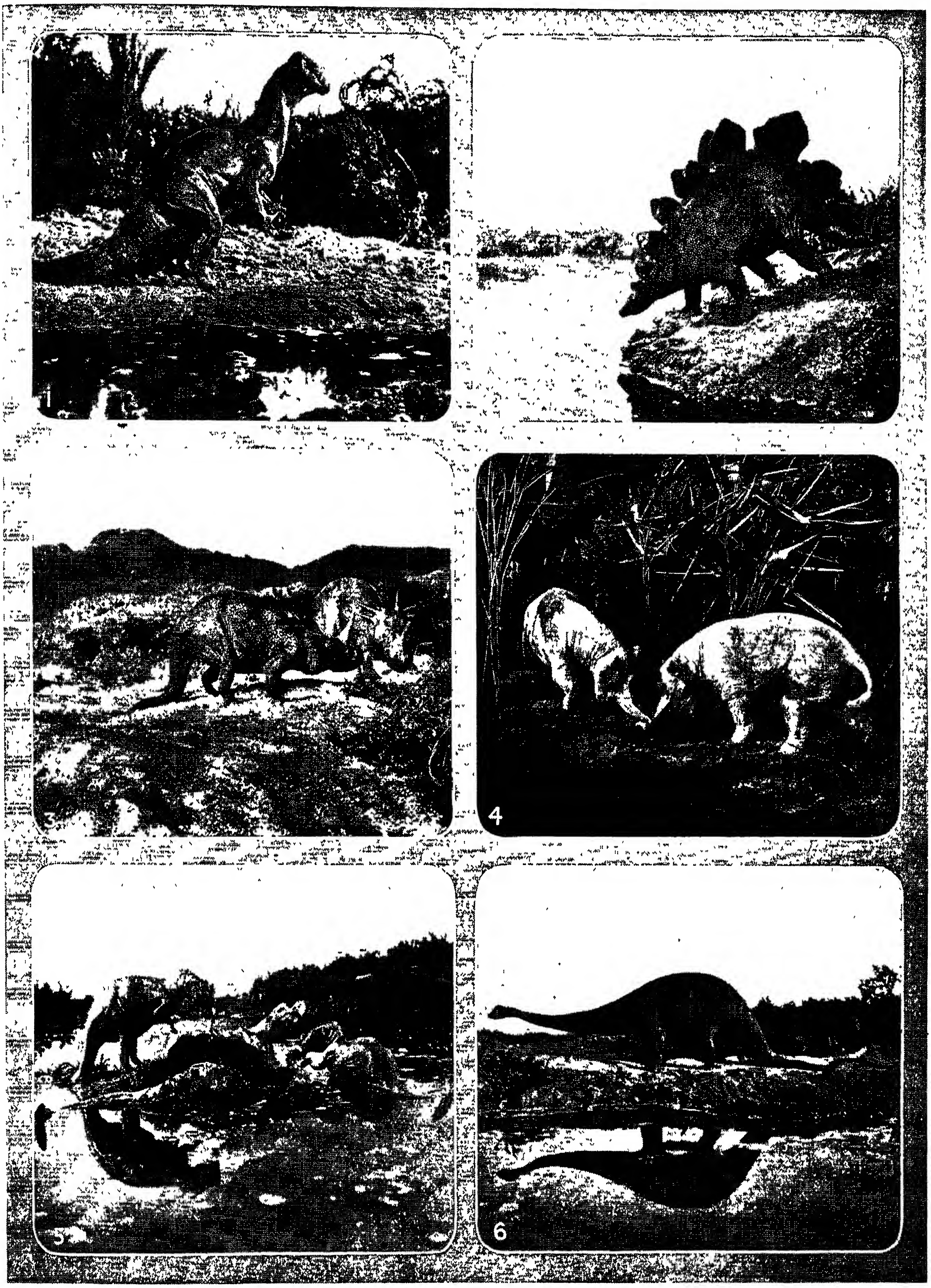
The Iguanodon.

The iguanodon (Fig. 1) was one of the group of dinosaurian reptiles which adopted a biped habit, running on the strong hind limbs and using the fore-arms for tearing vegetation. The feet were three-toed and like those of the flightless birds, while the fore-limbs we; four-fingered, one of the fingers being shaped like a spike. From the tip of the snout to the end of the tail measured nearly thirty feet in a large specimen of iguanodon, but much smaller forms have been found. In habits it was generally land-living, but it is thought that it could probably swim and may have fled to the water when pursued. Many of the dinosaurs were armed against the attacks of their predatory contemporaries, and in the stegosaurus (Fig. 2) this armour took the form of bony plates arranged along the backbone and of spikes on the tail. Ossicles and small plates of bone may have occurred on the skin. It is difficult to grasp the significance of all the plates on the back, but some protected the great nervous centre in the sacrum. The spikes on the tail may have been used in defence after the manner of a crusader's mace.

The Upper Cretaceous rocks of Alberta have yielded the bones of the styracosaurus (Fig. 3), an armoured dinosaurian reptile closely allied to the treceratops. It was smaller, being probably only twelve feet long. It is also distinguished by having only one large horn on the nose, and the bony frill over the neck is prolonged into a number of spikes. Like triceratops, it was a vegetarian with a toothless horny beak in the front of the mouth and the teeth at the back of the jaws. It was also very probably an egg layer. The photograph shows a pair disturbed while browsing. The arsinoitherium (Fig. 4), a huge beast the size of a rhinoceros, was among the most fantastic mammals which have ever existed. Over the nose were two massive, bony, sharp-pointed horns, and immediately behind them, over the eyes, two smaller, conical prominences. The whole formed an offensive, and defensive, armament, and figured largely in the contests of the bulls during the rutting season. The structure of the limbs is like that of the elephants in certain respects.

Ninety Feet Long.

The bipedal dinosaurs were of two kinds, vegetable feeders and flesh eaters. The ceratosaurus (Fig. 5) was one of the latter, and derives its name from the short bony horn on its nose. Like iguanodon, it ran on its strong hind limbs, also three-toed, but its fore-limbs were used for tearing flesh and its sharp sabre-like teeth were in the front of the jaws as well as on the maxilla. The diplodocus (Fig. 6) was a gigantic creature belonging to the order of extinct reptiles known as the dinosaurs, and is one of the largest animals known. It attained a length of nearly ninety feet, most of which was taken up by the long neck and the very long whip-like tail. The short head contained a small and lowly organized brain. The teeth were like lead pencils in shape and were restricted to the front of the mouth, where they were most suitable for raking in the plants used as food. As is shown in the photograph, this dinosaur inhabited regions with swamps, lakes or estuaries.



HOW PREHISTORIC ANIMALS APPEARED.

Book Reviews.

The Modern Dowser: A Guide to the Use of the Divining Rod and Pendulum. By LE VICOMTE HENRY DE FRANCE Translated by A. H BELL. (George Bell & Sons 3*s* 6*d*.)

I approached this book hopefully. Here, I said, is a book which is a guide It is not going to boast of the great things dowsers do. It is going to tell us how the mysterious operations of dowsing or water divining are done. And the book, I reflected, must be pretty good because it has evidently been worth while to translate it from the French. But my hopes, as the phrase has it, were doomed to disappointment I had not read far in the book before I realized that it appears to be intended not for the scientific man but for those who are interested in the "occult," and the occult, I ought to say, at its most credulous. I do not wish to be rude, but I have never read greater rubbish on a scientific or a pseudo-scientific subject than the contents of this work If the author, who appears to be an easy-going, simple and sincere man is right, then the external world known to the physicist and the chemist is wrong; is, in fact, all wrong

The author describes how he has gone about with a divining rod or, more frequently, with a pendulum suspended from his fingers and experienced the most remarkable happenings. The pendulum may vibrate in the ordinary way, or it may gyrate either clockwise or anti-clockwise, and the motions may be slow or rapid. This variety of motions the author has correlated with the presence, depth below the surface, and intimate nature of metals, metallic ores, rocks, wines, colours, waters and vegetables. For example, suppose you want to find the chief ore of lead, galena. (Probably you do not, but let us suppose that you do.) You obviously do not want to search the whole countryside looking for a vein of the ore a few feet wide only So you do this: "Take a pendulum made of a little bag containing ore, a thread and a little stick" After you have settled certain details, "you explore the horizon with the left arm extended. If the pendulum gyrates you have found the general direction of the deposit." Do this at various places and there you are, the deposit you want is found. The book is full of advice of this kind. No doubt the rod does move, no doubt the pendulum does swing, in the author's hands, but the book does not inform us from what source he gets the inspiration which correlates the motion with his clear statements about the amount and nature of waters, rocks, metals, and so on He sweats conviction on the subject, but what he is convinced about is at total variation with what we know in science "First of all we find that all edible vegetables give as a rule very few sets of gyrations [with the pendulum]—two or three, representing the qualitative or characteristic series. When you find longer series, say six or seven movements, be on your guard, for you are dealing with poisonous substances. This discovery, which has very important results, may seem at first somewhat extraordinary." Too extraordinary for most of us, I fear, dear author! Whatever this is, it is not ordinary dowsing

The remarks on water are revealing of both author and translator After asserting that the rate of mortality is directly dependent on the supply of good drinking water they continue: "Country people sometimes say that they are indifferent on the subject because they do not drink water. . . This is a mistaken idea. . . . Water is indispensable not only for man and beast, but is used in great quantities for cooking and washing and for cleaning of all kinds in the house and farm It is required for bathing by human beings and animals, for watering gardens and for extinguishing fires. The universality of the question is obvious."

A S RUSSELL.

A Bird Watcher's Notebook By J. W. SEIGNE With Drawings by PHILIP RICKMAN, and Photographs (Philip Allan. 12*s*. 6*d*.).

Mr. Seigne is one of those sportsmen who have learned that more pleasure can be derived from watching birds than from shooting them. He tells us in his preface that he has given up shooting on his property in Kilkenny, and has made it a sanctuary, chiefly in order to study woodcock.

He believes that two types of woodcock occur in Ireland, the red and the grey; the former he distinguishes as Irish-bred birds, and the latter (which are slightly smaller and arrive later) as migrants He gives details of his shooting bags to substantiate his theory, and a coloured illustration of the two types by Mr. Rickman seems to show the difference clearly The plumage of woodcocks varies greatly, but Mr Coward, in his "Birds of the British Isles," says that he is unconvinced that British woodcock are darker and larger than migrants. Only an examination of a large series of skins by experts could settle the point

The book is discursive. Some passages are loosely written, and contain unnecessary repetition. There are three chapters on woodcock and snipe, others deal with the pintail snipe and an alluring bird haunt in Mongolia, rooks and herons, and regularity in bird-life. Perhaps the two most interesting are those on vermin, one from the point of view of the bird-lover, and the second (written by Major Maurice Portal) from that of the shooting man. It is instructive to compare their conclusions Neither has a good word to say for the hoodie crow, the sparrow-hawk or the rat. Both agree that the kestrel and the merlin are usually harmless The worst Major Portal can say of ravens is that they sometimes spoil a grouse drive

As to the peregrine, Mr. Seigne thinks that its depredations on grouse are rare, and should be pardoned, but Major Portal considers it a nuisance where grouse and partridge are the main stock on a shoot. Magpies apparently came to Ireland from England Mr Seigne does not consider this to be yet another Irish grievance, but Major Portal condemns them as inveterate egg-stealers He is generally benevolent towards owls, except the little owl. The fox Mr. Seigne finds almost harmless in his sanctuary, but Major Portal has shocking tales to tell of his misdoings on grouse moors. His catalogue of vermin is naturally longer than Mr. Seigne's, but if all game-preservers were as discriminating as Major Portal few would find fault with them.

The book contains much first-hand observation Mr Seigne once saw a merlin carrying a bird which his keeper insisted was a young grouse The keeper fired, and the merlin dropped—not a grouse but a young merlin, which it had been trying to carry into safety He relates several instances of snipe carrying their young, and states that woodcock when transporting their offspring sometimes use the bill as well as the claws and thighs to support their burden. A friend of his who sent a detailed description of a woodcock carrying its young on its back to a distinguished ornithologist, received the "chilling reply" that such a feat was impossible We know that type of ornithologist! But, as Mr. Seigne remarks—and he might have quoted Gilbert White in support—one of the principal requisites for the study

of wild creatures is a perfectly open mind. He has heard of two other instances of woodcock carrying their young in this manner.

Mr. Seigne has powers of vivid description of scenery as well as of birds and beasts, he can make you see the mirage effects on a Mongolian lake whose waters "merged into successive waves of soft blue, until there seemed to be not one lake but a series of lakes hanging and quivering in the air", or, on a frosty morning, "the bold outline of distant mountains etched in pink against a saffron sky." His book will be enjoyed both by bird-lovers and sportsmen.

E. W. HENDY.

The Organization of Farming. Vol. I · "Production" By G T. GARRATT. (Heffer.)

The state of agriculture is prominently before the community at the present time. Few can be ignorant of the fact that arable farming in particular is in the trough of an acute depression, and this fact will be further emphasized during the coming Parliamentary Session when agricultural legislation may well occupy an important position in the Government's programme Those who wish to be well informed as to the situation should study Mr. Garratt's book, which analyses the position clearly, fully and fairly. It deals, however, with only one of the two main groups of agricultural problems, that of production, the first three chapters being occupied with a consideration of the relative merits of different types and sizes of farms, the next three with national and social considerations, the seventh with landlords, and the last with possible future developments. The examination of marketing problems, the second main group, is deferred to a second volume, which we hope will appear while the present Government's highly important Marketing Bill is still under discussion Marketing legislation is more feasible and more likely to produce early and beneficial results than an attack on the problems of production.

The agricultural problem is extremely complex. We have, within this small island, so many soils and climates, so many types of farming, so many conflicting interests An agricultural policy suited to one district and one type of farming is useless in another district. Protection itself is against the interests of those who buy large quantities of imported feeding-stuffs, although the dread of competition from overseas casts a dark cloud over the industry as a whole

Agriculture is undoubtedly inefficient in many ways, and Mr. Garratt lays his finger on many weak spots It is argued by some that to bolster up an inefficient industry by means of protective legislation and State aid is unsound, and merely perpetuates this inefficiency, but can increased efficiency come without such assistance? The industry is so diverse, scattered and unorganized that it is exceedingly doubtful if it can do much to help itself Admittedly we cannot imagine the land in this country lying altogether derelict. It will prove profitable for some system of farming, but that system may well be against national interests If agriculture works out its own salvation at present, it will certainly mean increased rural depopulation in the arable districts. If the farm labourer goes, it will be indeed difficult to get him back at a future date, and there is already every indication that many districts will experience a definite shortage of farm labour in the near future.

Mr. Garratt is afraid that his book may appear inconclusive. It is difficult to deal fairly with his subject and be otherwise. Yet he states two conclusions which ought to be emphasized

(1) "The real crux of the farming situation is the *net*, not the *gross* production per man" With low prices, farmers may go in for "low" farming; total production is low, but few men are employed, expenses are kept low, and the net production per man employed is accordingly high

(2) We have many excellent and efficient farmers, but "they are hampered by a land system which prevents them from developing satisfactory and properly equipped farming units" Mr. Garratt, after carefully examining the facts, favours public ownership of land Possibly the author is inclined to over-emphasize this point Many able farmers carry on successfully under bad landlords, and farming is such an old industry that in the great majority of cases farmers work on systems well adapted to their various special local conditions. We must also remember that we still have large numbers of well-managed and wealthy estates—although ruinous taxation is steadily reducing their numbers—and in many of these cases the landlord does considerably more for his tenants than any public body could do It would be a national misfortune to remove this type of landlord.

Rothamsted Experimental Station,
Harpenden. H. G. MILLER

Bird Watching and Bird Behaviour By JULIAN HUXLEY (Chatto and Windus. 5s).

Professor Huxley's success at making biology comprehensible to the layman has been so conspicuous that his more particular achievement as one of the most brilliant and penetrating of bird-watchers receives too little credit The emphasis wisely placed on bird-watching in the series of broadcast talks here reprinted should enable his listeners and his readers to appreciate the qualities on which his ornithological reputation must largely depend In zoological journals his contributions to the elucidation of courtship and related problems are substantial, and it is surprising to reflect that this is the first of his books, by which the wider public must judge, to do anything like justice to his individual experience and general grasp of the contemporary questions of bird-watching. Freed from the limitations of scientific writing he has been able to range untrammelled over his field, and in following his lively concentrated account this remarkable breadth of reference must surprise even those who are well acquainted with his work. How many first-rate observers are there, with a comprehensive knowledge of literature and current work, who could illustrate so aptly a brief survey from their own notes not only in Europe but in America, Equatorial Africa and the high Arctic?

Anyone who has had the task of phrasing a popular work on ornithology in such a way as to avoid ambiguity or over-statement, while touching on many points about which curiously little is known, will appreciate the skill which has left the present reviewer with only a single detected opening for disagreement in more than a hundred packed pages In speaking of "the transference of emotion or its expression into unusual channels" Professor Huxley quotes the instance of throwing stones into an osier patch which harbours some sedge-warblers, and continues:—

"On this the cock birds will almost invariably burst into song; song, the normal expression of sexual emotion and general well-being, has been commandeered as outlet for the birds' feeling of anger."

The necessity of assuming transference is not clear, nor does the definition of the function of song appear to cover all the facts. To take a familiar example, robins sing very intensely

in autumn when there is not only no sexual activity, but the individual intolerance appears as uncompromising between cocks and hens as between old and young or rivals of the same sex and generation. Nor does it account for the familiar poverty of song in, say, a tropical rain-forest, where "sexual emotion and general well-being" may be equally manifest The territorial theory has its shortcomings, yet in tentatively accepting song as one of the channels through which strong territorial feeling proclaims itself, we are less likely to find the facts troublesome to the theory For example, in the case quoted, the trespass of man or missile serves equally with the sight or sound of a rival as a trigger to release (at the appropriate season) a burst of territorial emotion. Transference would be a more plausible interpretation of the much rarer phenomenon of male birds in the heat of a scuffle uttering the characteristic song-form of the species.

The illustrations are notably well chosen and well reproduced

E M. NICHOLSON.

The Khoisan Peoples of South Africa. By I. SCHAPERA, M A, Ph D. (Routledge. 31*s.* 6*d.*)

In this book, which is the first of a series designed to cover the ethnology of South Africa, the author discusses the social, economic and religious life of the Hottentots and Bushmen. Dr. Schapera has aimed at providing, in one volume, a comprehensive review of Khoisan culture, and his own observations are supplemented by a critical summary of former investigations.

The social, economic and religious customs of the Khoisan peoples have already been described by many students of African culture, and are, no doubt, comparatively well known. But Dr Schapera throws interesting light on the decorative and pictorial art of the Hottentot and Bushman, the significance of their dances and their conception of music, about which little has hitherto been known The pictorial art of the bushmen consists of paintings and engravings executed on rock surfaces, and is, perhaps, the most remarkable feature of their culture. The practice of this art seems to have died out almost completely, a necessary consequence, no doubt, of the virtual extermination of the artists themselves. The paintings and engravings remain, however, as a valuable record, and have proved an important link in the chain of evidence connecting the bushmen with the prehistoric cultures, not only of South Africa but also of East and North Africa as well as of South-Western Europe.

The technical processes employed in the execution of the designs appear to have been fairly simple The rock surface in its natural state was employed as canvas; broad plane surfaces were preferred, but where these were not at hand, no trouble seems to have been taken either to polish the rough surface of the rock or to level it in any way. The only implements used in making the engraving were small pieces of hard stone with a serviceable point. With these, the artist would laboriously chip away at the rock surface until his design was complete. Some of the engravings consist of only an outline drawing, produced by more or less rough pointing and punching, giving the design an appearance known as "pocked." Sometimes the outline is completely filled, so that the engraving consists in a design uniformly pocked over the surface. Some of the engravings done in this way are extremely beautiful.

Recent investigations have shown that the paintings and engravings are not all of the same age, but that a chronological sequence can be seen in style and technique. Moreover, different styles occur in different geographical areas. The objects depicted are for the most part animals and human beings, although inanimate objects also figure occasionally, such as weapons, clothes, or trees.

Public interest in Africa is steadily growing; administrators, economists, educationists and missionaries are each in their own way striving to mould the life of the native on European lines Those who doubt, or at least find difficulty in understanding, the culture of the African—and they appear to be numerous—should certainly read Dr. Schapera's book. Much of it is not new, but the results of former investigations are, for the most part, not readily accessible, and such a survey as this is welcome

Your Character from your Handwriting By C. H. BROOKS (Allen & Unwin 3*s* 6*d*).

Although the practice of reading character from handwriting is by no means new, it is only recently that this interesting study has come to be recognized as a coherent science. Even now it appears largely to be in an experimental stage Mr. Brooks has aimed at outlining the rudiments of graphology, and sets out to show that a simplified technique for the analysis of handwritings can be learned by any person of normal intelligence who is sufficiently interested in the subject to read his book. There are certain branches of science, particularly those in the experimental stage, which it is impossible to treat adequately in a small guide book. Mr. Brooks' book is inadequate, not through any failing on the part of the author, but because his subject is altogether too vast and intricate to be disposed of in a hundred pages There is a foreword by Dr. Robert Saudek, who recently contributed to *Discovery* on the subject.

So many factors must be taken into consideration before attempting an analysis of handwriting that the subject is by no means as simple as it may seem Forms of handwriting are not determined exclusively by the character of the writer Character is only one of a number of influences Manual dexterity, a good memory for forms, ill health, bad materials, or the method of writing learned in childhood all help to form a hand. The author sets out to show how these traits may be distinguished, but it seems doubtful whether it would be advisable for a beginner to attempt an analysis after such brief instruction.

An illustration shows two sentences written by a man in his normal hand A second illustration shows the same text written in an enlarged, embellished and more elaborate style. The artificial writing appears to be the work of an entirely different person. It is considerably larger and exhibits eccentric curves and ornamentations for the simple forms that distinguish the natural hand. The author points out that, on closer examination, the disguised writing is found to be inconsistent, and that the writer frequently fails to sustain the assumed role. It is to be concluded that the writer of this passage was normally of a simple, unassuming disposition and the ornamentations in his second passage were not a true indication of his character. Mr Brooks gives another example to show how a man who normally wrote with a flourishing hand was asked to write as simply as possible. The results of this experiment show that the writer was normally an ostentatious man, and that the simple writing of his second specimen was artificial This, of course, is quite straightforward, but how is one to decide, in attempting analysis of a flourishing hand, whether the writer merely added the ornamentations out of sheer exuberance of spirits and was normally a quiet, retiring man, or whether he was by nature ostentatious and the inconsistencies were due to an attempt to appear retiring?

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Editorial Notes.

This month we are fortunate in publishing the first fully-illustrated account of the excavations at Verulamium, which were begun last summer under the direction of Dr. Mortimer Wheeler. The historical value of the site had been recognized for a long time, but only this year was it possible to undertake exploration on an adequate scale. In the first place the Corporation of St. Albans bought about half the Roman city; later the Crown Commissioners acquired further lands, and they have just bought nearly five thousand acres of the adjoining Gorhambury estate. This immense area is bounded in part by Watling Street, the famous Roman road. The excavations are of the greatest importance, since it should be possible for the first time to acquire extensive information on a principal British city before, during and after the Roman occupation. The preliminary work has thrown valuable light on various matters. We reproduce photographs showing the cellar of a small shop built in the second century, in which various architectural features were discovered. The cellar must have been buried during a reconstruction of the locality in about A.D. 300, and in consequence it has been found in a remarkable state of preservation. Its flint walls are still cemented and white-washed, and there is evidence of the wooden shelving with which they were originally fitted. The importance of further excavations is clearly explained by Dr. Mortimer Wheeler. One of the problems to be solved is the exact position of the prehistoric metropolis which Caesar himself may have entered in 54 B.C. A great opportunity will be lost unless further funds can be raised for the work, and we hope that as many readers as possible will send a donation to the Excavation Committee.

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The view that there is no doubt about the reality of "ball" lightning, a phenomenon which has long been questioned, was expressed by Dr. G. C. Simpson in a recent lecture at Oxford. Ball lightning is probably the most interesting form of lightning discharge. The balls appear to fall from the clouds or are seen moving along at a slow pace near the ground; they frequently enter houses through open windows, and have even appeared mysteriously within closed rooms. Their size varies from the size of a pea to the size of a man's head, and they are usually circular in shape. The balls do not appear to possess heat, for they have been seen to pass among the folds of a curtain without leaving any signs of burning. They usually disappear noiselessly, but have been known to explode with a loud report, doing considerable damage. Several accounts of ball lightning are recorded by responsible observers, the best-known examples being in Rome in 1902 and near Toulon in 1929.

* * * * *

A new type of flint implement has been discovered in the Milton Road gravel pit at Swanscombe, near Northfleet, Kent. This gravel pit is a well-known archaeological site, which has already produced evidence of considerable importance in its bearing upon the cultures of the Lower Palaeolithic period in England. Excavations in 1913 revealed three strata of gravel at different levels, separated by sand and loam. In the bottom gravels the excavators discovered rough flakes of flint associated with the bones of the straight-tusked elephant (*Elephas antiquus*). In the middle gravels, ten feet above, were a number of hand-axes, some of which are doubtfully

classified as belonging to the Chelles or earliest phase of palaeolithic culture. The greater number were of the characteristic St Acheul type of hand-axe, representative of the second cultural phase. The latest discovery has been made by Mr. R. H. Chandler, who found an implement of a new type in the bottom gravels which had previously produced rough flakes only. It is a kind of chopper made by striking flakes from a flint nodule by alternate blows from right and left. Associated with it were cores from which flakes had been struck, together with anvil stones. The discovery presents several points of interest. This industry has no known parallel either on the Continent or in this country, with the possible exception of somewhat similar implements found at Clacton-on-Sea and at Stoke Newington.

* * * * *

On another page, a new method of telephoning from trains is described by the inventor of the system, who explains how conversations may now be carried on regardless of the speed at which the train is travelling. The most remarkable call so far made took place between the chairman of the Railway Research Service in London and another railway expert who was travelling at sixty-five miles an hour on a train in Canada This was the first telephone call made across the Atlantic from a train. There was very little trouble in completing the connexion and the reception was perfectly clear. The two-way telephone system has been perfected after many months of careful research. The voice of the passenger is " broadcast " from the train to the telegraph lines which run parallel with the track, where it is picked up by the normal telephone circuit.

* * * * *

Provisional arrangements are announced for the centenary meeting of the British Association, which will take place in London next September. The President-elect is General Smuts, F.R.S., who will deliver the inaugural address at the Central Hall, Westminster. The sectional meetings are to be held in the various museums and institutions at South Kensington, thanks to the co-operation of the authorities, and the reception headquarters will be in the Great Hall of the University of London. The Association first met a hundred years ago in York, and an official party will visit the city to commemorate the occasion. Another interest is provided by the Faraday Centenary, which will be celebrated under the auspices of the Royal Institution a few days before the meeting. Those intending to take part in the proceedings are advised to make early application for membership, as the accommodation at the more important ceremonies will be limited

* * * * *

Further observation of the planet Pluto has confirmed the preliminary views on the nature of the object, which was at first disputed among astronomers. Professor Henry Russell, who described its discovery in our August number, has published further details in the *Scientific American*. The calculations of Dr. Crommelin in this country and of Bower and Whipple in California are in close agreement, and definitely prove its claim to be a major planet Although the eccentricity and inclination are greater than for any of the eight principal planets previously known, they would pass as moderate among the asteroids, and there can be no hesitation in assigning the new body to the ninth place among the sun's more important attendants. There is nothing cometary about it at all; its orbit is far too near a circle and it is eight or ten times as far away as the distance at which even the brightest comets fade out into complete invisibility.

* * * * *

A remarkable discovery affecting the treatment of anaemia is claimed by two American doctors. In explaining its significance, Professor McClure of Princeton states that in this disease the blood-forming tissues of the body fail to renew the blood corpuscles, which undergo extensive degeneration. Although it has been known for some time that an extract of liver would activate these tissues, the determination of the active principle in the liver which brings about this response has remained a mystery. " Dr. West and Dr. Howe have made a significant and far-reaching advance. First they isolated from the liver a product possessing marked acidic properties, which proved highly active when administered to patients with pernicious anaemia. From this product they later derived a finely crystalline salt, which retains its biological potency after three recrystallizations." The importance of this result is too obvious to require emphasis.

* * * * *

The existence of a solar cult among the Indians who once inhabited Colorado is suggested by the discovery of some circular stone enclosures to which no other purpose can be ascribed. It is thought that the enclosures must have had a purely ceremonial significance, since their arrangement does not suggest a protection against the weather or a possible enemy. Their circular shape, and the presence of a central monolith, support the suggestion of sun worship, although no similar constructions have been found elsewhere in south-west America.

The Excavation of Verulamium.

By R. E. M. Wheeler.

Keeper of the London Museum.

From an historical standpoint the site of Verulamium, near St. Albans, is potentially the most important in Britain. Excavations were begun last summer under the direction of Dr. Wheeler, who describes the first results and the great possibilities of the further work which he hopes to carry out in the spring.

"*In Verolamium, a forgotten Citie, sometimes neere Saint Albones.*
'Churches that interr'd the dead,
Here themselves are sepulchred;
Houses where men slept and wak't,
Here in ashes underrak't·
In a word to allude,
Here is Corne where once Troy stood,
Or more folly home to have,
Here's a Citie in a grave
Reader, wonder thinke it then,
Cities thus would die like men,
And yet wonder thinke it none,
Many cities thus are gone.'"*

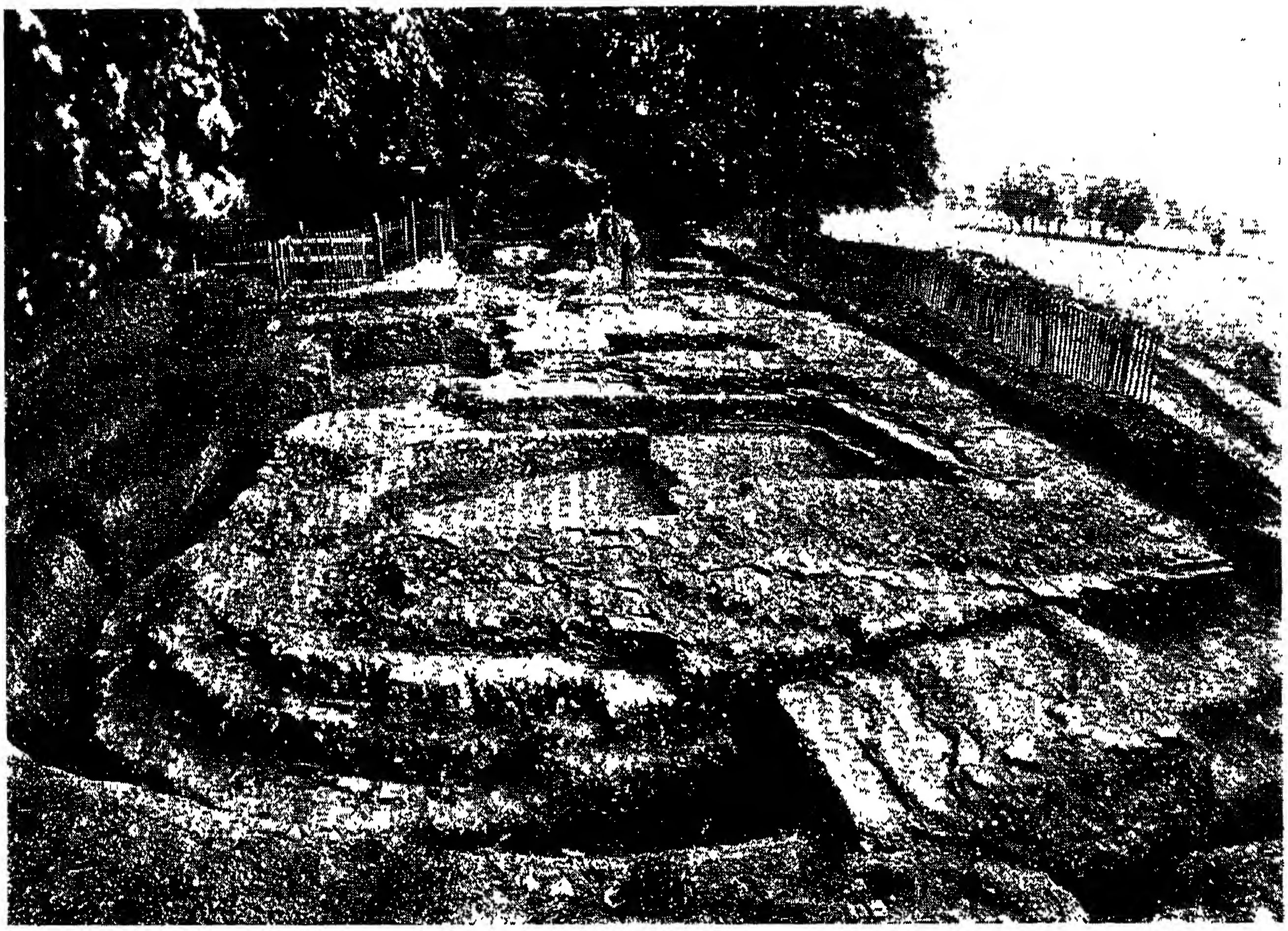
THESE quaint and halting verses, from an anonymous work published in the year after Francis Bacon's death, epitomize the double interest which draws the visitor to Verulamium: the remains of a famous British and Roman city, and the pervading "atmosphere" of Baconian England. In the little church of St. Michael, in the very midst of the fields "where once Troy stood," the image of Francis Bacon, Lord Verulam, sits meditatively as he used to sit—"*sic sedebat,*" according to the well-known words on the pedestal; whilst a mile away are the charred relics of the ornate mansion where he had lived. In St. Michael's churchyard is, on the other hand, a part of one of the columns of the forum of Verulamium, and other remnants of the Roman market-place have been uncovered from time to time in the garden of the neighbouring vicarage. Moreover, seventy years ago a theatre—the only Roman theatre hitherto identified in Britain—was temporarily exposed and planned a hundred yards or so to the northward. Indeed, at many points in the surrounding landscape, earnest antiquaries and ardent Baconians have, for their various purposes, dug intermittently into the soil, and the former at least have won reward. But never until 1930 have organized excavations on an extensive scale been attempted here, and it may be of interest to record briefly both the purpose and the origin of the work which is now in progress.

Historically, Verulamium has three outstanding claims to our attention. At the time of Julius Caesar's invasions, it was apparently the headquarters of his principal opponent Cassivelaunus, and, as such, was the nearest approach to a metropolis that south-eastern Britain could show. Its pre-eminence thus antedates that of London by at least a century. Secondly, although ultimately surpassed by Londinium in size and importance, it achieved under the Roman régime the highest rank attainable by a provincial city—that of *municipium* or "municipality." Thirdly, it was the home of the most celebrated of Romano-British martyrs, St. Alban, to whose shrine came St. Germanus of Auxerre in the year 429, thus, incidentally, providing the only reliable historical reference to a British town during the dark period following the break with Rome in 410. These three historical "contacts" present certain special opportunities to the archaeologist, notably (1) the possibility of acquiring for the first time some extensive knowledge of the size and nature of a first-class British city on the eve of the Roman conquest; (2) a chance of ascertaining (again for the first time) something of the economic history of a first-class Romano-British city; and (3) the only clear opportunity in Britain of finding out something about the life of a Romano-British town after the severance of Britain from Rome. Indeed, both historically and archaeologically Verulamium is second in importance to no ancient site in the kingdom.

Preliminary Work.

The appropriate moment for exploring these various possibilities arrived this year, when the enlightened corporation of St. Albans acquired nearly one half of the Roman city; subsequently the Crown has bought a considerable slice of the adjacent country. Lord Verulam himself has also offered every facility for archaeological work; and the accompaniment of these fortunate coincidences was the formation of a Verulamium Excavation Committee under the

* From *A Helpe to Discourse, or a Misselany of Seriousnesse with Merriment* London, 1627. Communicated to me by Miss Joan Evans.



VERULAMIUM: GENERAL VIEW OF THE "LONDON GATE"

In the foreground are seen the foundations of one of the flanking towers of the "London Gate," which dates from the second century A.D. The workmen in the middle distance are standing on the two main roadways through the gate

presidency of the Marquess of Salisbury and the chairmanship of the President of the Society of Antiquaries (Mr. C. R. Peers). Accordingly, during August and September an intensive preliminary programme of work was carried out, with results that may here be summarized.

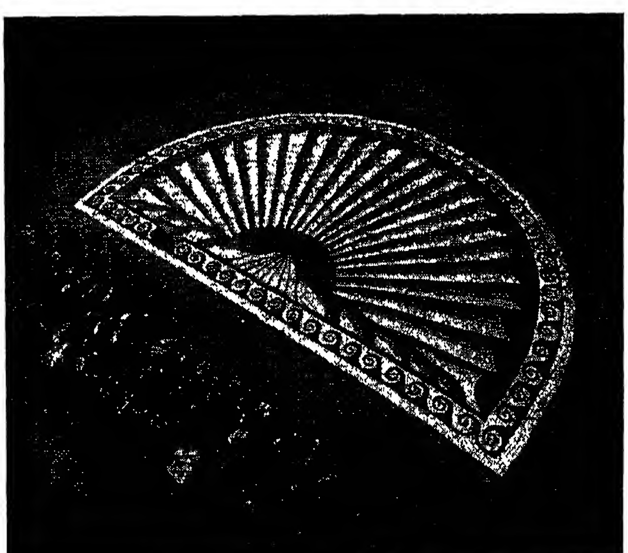
To-day the most obvious vestige of the Roman city is the line of its defences—two miles in length and enclosing an area of two hundred acres. Excavation has now shown that these defences were constructed about A.D. 120-140, approximately at the time when Hadrian's great frontier-wall was being built in the north, when the city of Uriconium in Shropshire was erecting its forum, and when towns such as Alchester in Oxfordshire were likewise girding themselves with walls. It was a period of consolidation rather than of military prowess, but of consolidation on a lavish scale. The emperor Hadrian had at heart not merely of the permanence of Rome in matters political and military, but also the majesty and dominion of that great classical culture of which Rome was the effective heir. And, after eighteen centuries, the huge defences of Verulamium impress the visitor less, perhaps, as a mere military work than as an imperial gesture on the grand scale. The wall of flint and brick, 10 Roman feet wide at the base, backed by a bank 45 or 50 feet wide, and fronted by a fosse no less than 80 feet broad, was indeed a formidable defence; but its main southern gateway—the gate which faced London, astride the Watling Street—was of that expansive, monumental type to which the greater Augustan cities of Gaul have accustomed us. Set between two projecting round-fronted towers, the fourfold opening reminds us of the Gate of Augustus at Nîmes, or of the two up-standing gates at Autun. It savours something of the arch of triumph, and its construction may be thought to have synchronized rather with a phase of successful domination than with one of insecurity and precaution.

The "London Gate" was approached by the long-derelict Roman Watling Street which, as uncovered 150 yards outside the gate, is found to have begun as a 10-foot road of concrete and, after various remodellings, to have ended as a well-cambered but loosely metalled road 30 feet across. At the gateway

itself are traces of a road which may be of still earlier origin. During the seventy or eighty years in which the Roman city had existed before the building of the Hadrianic defences, the site of the gateway was not unoccupied At least one Roman house, with cement floors and timber walls, had stood here, alongside a cobbled street which likewise underlay the structure of the gate. The street-paving had been laid upon the natural surface of the ground and, as presumably the first Roman Watling Street, is perhaps the oldest paved road yet found in Britain.

Within the circuit of the Roman defences, two streets and two buildings were identified during the season. One of the buildings was a dwelling-house, built of timber, with floors of clay or gravel, during the early years of the Roman occupation and rebuilt with flint foundations early in the second century The rebuilt house had at least two well-laid floors of mosaic, of which one has survived intact. This, the floor of an apsidal room projecting on to one of the streets, bears an elaborate scallop-shell pattern which illustrates the bold use of contrasted colours characteristic of the earlier and better mosaic-workers This pavement has since been raised, and will ultimately find a place in that "Verulamium Museum" which it is now necessary to envisage.

Later, about A.D. 300, the house was again rebuilt, and alongside it was erected a structure of timber, with nave and aisles like a medieval barn, and over ten bays in length. This structure may in fact have been a barn or warehouse; but it also somewhat



SCALLOP-SHELL MOSAIC

This mosaic floor, discovered in a house of early second century date, bears an elaborate pattern carried out in bold colours

CELLAR OF A ROMAN SHOP.

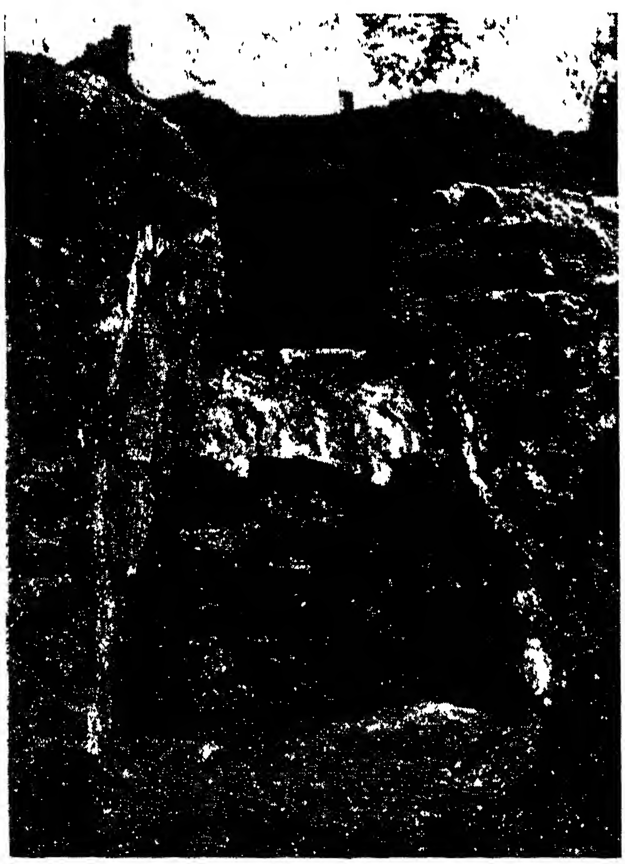
The door-sill of the cellar still intact, and the back wall contains sockets for shelf-brackets On the right is a millstone.

resembles certain aisled or "basilical" dwelling-houses which were built in southern Britain during the third or fourth centuries, and may be referable to German prototypes. However that may be, one point of interest was clear about this and other late buildings at Verulamium: the standards of construction show a marked deterioration under the later Empire, a feature which accords with evidence already obtained from Uriconium and other Romano-British towns. At Verulamium, the process of degradation (in the very restricted area already explored) is carried yet a stage further by a final reversion to floors roughly patched with clay, more primitive in character even than the floors of the earliest hutments. This process of apparent economic or cultural devolution in Romano-British urban life has wide historical implications, and will be examined further as the work of excavation proceeds.

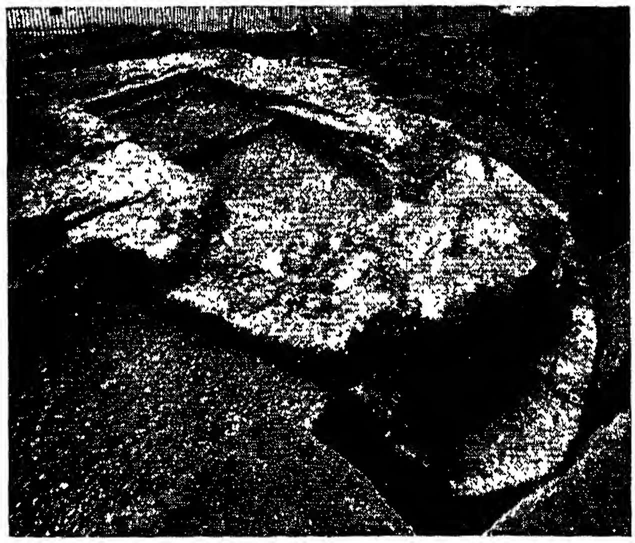
Of greater architectural interest was a small building, probably a shop, which fronted upon an adjacent street. At the back of this building, and forming part of it, was a cellar which, built in the second century, had been disused and buried during a general reconstruction of this area about A.D. 300. Its early

burial had preserved it almost intact. Its flint walls were still cemented and white-washed, and bore upon them the evidences of the wooden shelving with which they had been fitted. Two doorways bore the sockets for former timber-framing, and two large crevices in one of the walls had held the massive supports possibly of a crane for lifting heavy jars or bales out of the cellar. But most interesting of all was a window which remained in one of the walls—a rare survival in Romano-British architecture. Jambs and sill were widely splayed, and sockets indicated the former presence of a timber sill or frame which doubtless held wooden or iron bars.

After fulfilling its original purpose for a time, the cellar was used as a rubbish-dump, and was filled with bric-à-brac of second and third century date—great quantities of pottery both of Gaulish and of native manufacture; pipe-clay statuettes of Venus, perhaps from some domestic shrine; coins, trinkets and a much-worn millstone which can be seen, still lying upon the floor, in the photograph reproduced on the previous page Eventually, the whole dump had been carefully levelled and sealed by means of a layer of clean



SHOP CELLAR WINDOW.
This view shows the whitewashed jambs and sill, the latter cut back as a seating for a blocking inserted in Roman times. Above the masonry sill are the sockets for a timber sill or fram-work.



WATLING STREET
Foundations of a second century gate-tower at Verulamium. The cobbled surface of Watling Street, which ran across the site before the gateway was built, is seen in the foreground

sand containing only a few coins of the latter part of the third century.

So much, in the meantime, for the interior of the Roman city. Outside the walls lay the cemeteries, of which one was discovered and partially explored near the site of the north gate. But our excavations had thus far failed to throw light on one important problem—the problem of the whereabouts of the prehistoric metropolis which Caesar himself may have entered in 54 B.C. In pursuing this problem, we directed our attention to an outlying earthwork which butts upon the north-western side of the Roman defences. Here towards Praewood are, as excavation showed, two sides of a large fortified enclosure which partly underlies the northern end of the Roman city. Its defences consisted of a bank and ditch, each 50 feet wide, and the bank was revetted on its inner side with a vertical wall of turves. In the material of the bank was no Roman but much late prehistoric pottery; from which it may be inferred that the defences are either themselves of late prehistoric date or, at the latest, were constructed by the Romans at the time of their arrival and before Roman potsherds had begun to litter the site. Whichever inference be proved by further exploration, this much is already clear from the abundance of prehistoric pottery on this site: here or hereabouts, on the higher ground to the north-west of the centre of Roman Verulamium, lay the prehistoric Verulamium which was for a time the greatest of British cities. If the Verulamium Excavation Committee receives the financial support which the magnitude of the work in front of it demands, the investigation of this and other problems will be resumed next spring.

Telephoning from Trains.

By J. C. Burkholder.

Chief Engineer of the Canadian National Telegraphs.

A system inaugurated this year by the Canadian National Railways makes it possible for the first time to telephone to and from moving trains simultaneously. The inventor here describes the system, which marks an important step forward from a method of communication already employed in German trains.

THE train telephone system inaugurated this year by the Canadian National Railways is the first two-way circuit to be established on a moving train. The invention is not unique, for a system of this kind was inaugurated some time ago in Germany and is in use on trains there. Voice transmission from German trains, however, is a slow process, and involves switching over from speaking to listening, the two processes being very difficult to carry out at the same time. The method developed in Canada is somewhat different, and it is believed to be the only system of its kind in operation outside Germany.

The Exchanges.

Communication is provided between a telephone set on a moving train which, with its associated equipment, is called the train station, and a telephone set in a building on the railway line, and adjacent to the telegraph lines, which is called the terminal station. The telephone set at the terminal station is, of course, an operator's set, or a " central," for it is at this point that the long distance telephone lines are connected to the new system. Each station consists of a transmitter and receiver, a circuit for connecting these to a telephone, the necessary power supply and antennae systems. It was found necessary to have separate transmitting and receiving antennae at each station. At the terminal station, use is made of the telegraph lines running parallel to the railway tracks for this purpose. Half the wires are used for the transmitting and half for the receiving antennae. These are connected to the transmitting and receiving sets through special filters, so that there is no interference between the new system and any telegraph or telephone equipment already operating over these wires. In other words, telegraph wires already loaded with telegraph messages and telephone conversations are also used to carry the high frequency currents employed in the new system. At the train station, the antennae consists of two groups of four parallel wires on the roof of the car. It is considered that this is a distinct advantage over the German system, which has an antennae extended over the tops of several cars necessitating the use of complicated coupling devices to allow the cars to be separated. Considerable difficulty was experienced, however, in working such short antennae at the low frequencies used, and special loading coils had to be employed in order to transfer sufficient energy between the car and the telegraph lines Incidentally, the receiving antenna is also used for the simultaneous reception of broadcast programmes.

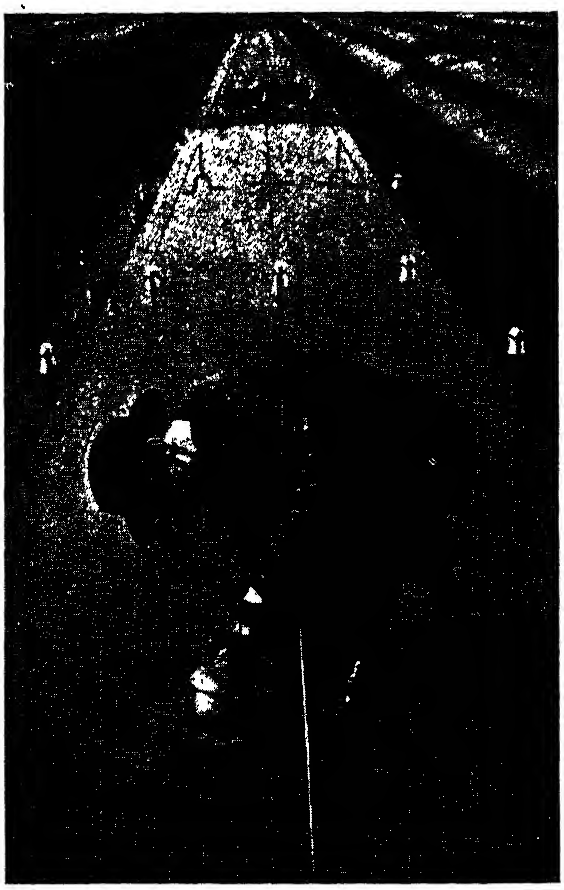
The equipment at terminal and train stations is almost identical. The transmitting unit comprises a voice frequency amplifier and blocking circuit, low frequency oscillator and modulator, band pass filter, and high frequency oscillator and modulator. This is coupled to a fifty-watt power amplifier by a double-tuned circuit. On the train, the power amplifier output is coupled to the antenna and at the terminal to the telegraph line. Different carrier frequencies are used for the car and terminal.

Two-way Transmission.

Satisfactory one-way transmission, from the train to the terminal station or *vice versa*, has been secured by using a single antenna on the car and a switch for talking and listening. In early tests, however, as soon as it was attempted to speak both ways at once it was found that the transmitter paralyzed the receiver at the same station. This was overcome by using two antennae at each station, utilizing special filters between them and the sets and sharply tuning the two car antennae. By this means, satisfactory two-way or duplex communication was obtained, although special means had to be employed to connect the system to the ordinary telephone. The power necessary to operate the various parts of a set is obtained from a small motor generator. At the train terminal, this is driven from the car storage batteries, and at the terminal station from the 110-volt lighting circuits. The generator is a multiple winding machine, and supplies the potentials for the plates and filaments of the vacuum tubes, the telephones and the signal

circuits. This provides a complete self-contained set which, incidentally, has been so designed as to take up a minimum of car space.

In order to transmit the voice frequencies between the train and the terminal without a physical connexion, it is necessary to employ some medium which will carry the voice frequencies between the two points. This is accomplished by varying the amplitude of a high frequency current, which can be effectively radiated by an antenna, so that the envelope or wave shape of the high frequency current corresponds to the frequency current. This process is called "modulation." In an ordinary radio set, the modulated high frequency current is picked up by the receiving antenna, is amplified, rectified, or "demodulated" and then amplified again at voice frequency. Somewhat the same process takes place in the train telephone system, but there are additional features, such as carrier suppression, double modulation, and the fact that only a portion of the products of modulation are radiated from the antenna, which are rendered necessary by the special nature of the problem.



CONNECTING THE ROOF WIRES

The author, who is the inventor of the telephone system here described, is seen connecting a transmitting lead-in to the roof of a train.

The modulation process is called a "carrier transmitted" system. The three major products of modulation are the original carrier, the upper side-band and the lower side-band. Thus, if a carrier frequency of 100 kilocycles is modulated by a voice frequency of 1,000 cycles, the products of modulation are the original carrier frequency of 100 kilocycles, the upper side-band of 101 kilocycles, and the lower side-band of 99 kilocycles. It is not necessary for the transmission of the voice frequencies that these three parts should be transmitted. The carrier can be eliminated at the transmitting end and supplied at the receiving end by a local oscillator; further, either one of the side-bands can be eliminated without detriment to the received speech. It is on account of the single side-band feature that double modulation is used. The band filter and directional filters used in the train telephone system differ from the tuned circuits employed in radio sets, in that, in a tuned circuit, the circuit is resonant or responds to one frequency much better than any other. On the other hand, the band-pass filter offers very little attenuation or loss to a certain band of frequencies (say 25.8 to 28.2 kilocycles, as in this system) and a very high attenuation to frequencies above and below this band. The directional filter offers very little attenuation to frequencies on one side of a certain frequency (cut-off frequency) and very high attenuation on the other. Where the frequencies passed are lower than the cut-off frequency, the filter is called "low pass." When the frequencies passed are higher than the cut-off frequency, the filter is called "high pass." It is necessary to give this description so that the sequence of operations which follows may be understood.

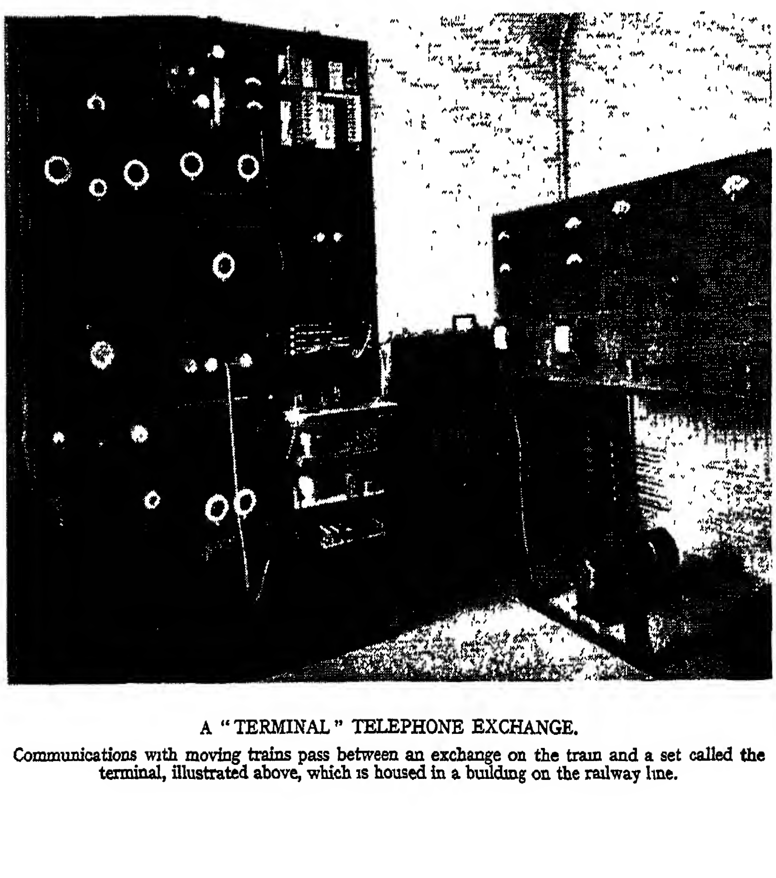
The output from the subscriber's telephone is amplified in the transmitting voice frequency amplifier and passes to the low frequency modulator. The blocking circuit associated with the amplifier makes the receiving circuit inoperative during the talking period A frequency of 28.6 kilocycles is also impressed on the modulator grids. The action of the modulator is such that the carrier frequency of 28.6 kilocycles is balanced out, leaving the upper and lower side-bands as the major products of modulation. The band-pass filter, which follows the low frequency modulator, allows the lower side-band to pass with an attenuation of six decibels, while offering a loss of 20 decibels to the carrier frequency of 28.6 kilocycles, and a still higher attenuation to the upper side-band. The process of modulation is repeated in the high frequency modulator, where a carrier frequency of 102 kilocycles or 152 kilocycles (depending on whether the set is for terminal or train use), is modulated by the lower side-band of the first modulation. The lower side-band of the second modulation is selected by the tuned circuit, which couples the high frequency

modulator to the power amplifier. The amplifier is composed of a low power linear amplifier, working into a high " C " biased 50-watt power tube.

When it is considered that the output power from the transmitter is roughly two hundred million times the input power to the receiver, it is obvious that some means must be taken to separate the transmitted speech from the received speech, and also that the filters used for this purpose must necessarily have a complicated structure. The difficulties are further increased because the receiving antenna cannot be at any great distance from the transmitting antenna on account of the physical and electrical limitations of the radiating surfaces. If filters were not provided, there would be considerable side-tone, and the slightest coupling between the output of the receiver and the input of the transmitter would be sufficient to start the whole circuit into oscillation. The blocking circuit, further, removes any tendency towards side-tone.

The car antenna consists of seven strands of copper wire, strung on insulators about twelve inches above the car roof. The three centre strands are used for transmitting and the other four wires for receiving. Both transmitter and receiver are coupled to their respective antennae by variometers which provide very sharp tuning of the antennae. A ground is made to the steel trucks of the car. At the terminal, the transmitter and receiver are coupled by loading inductances and condensers to separate pairs of wires. The separation of the transmitting and receiving antennae and the line helps considerably to reduce the interference mentioned above. From the coupling equipment, the received signal passes to a directional filter which, on the terminal set, passes all frequencies below 80 kilocycles and, on the train set, all frequencies above 100 kilocycles. The directional filter is followed by a band-pass filter and a two-stage tuned amplifier. The output of the amplifier feeds into the double demodulator. The demodulator accomplishes the reverse process of that performed by the low frequency modulator and high frequency modulator on the transmitted signal. The output of the last stage of demodulation passes through a low pass filter to the receiving voice frequency amplifier where it is again amplified. Both the high frequency and the voice frequency receiving amplifiers have gain controls, so that the received level can be maintained at the proper value.

The signal control circuit is arranged to notify the operator when a call is being placed from the other end, and also to place the transmitting equipment automatically in operation. Thus, when the telephone operator desires to establish a connexion with the train, she operates a ringing key, connecting the ringing current with the telephone line between the telephone exchange and the terminal. The ringing current operates the signal control circuit at the terminal and rings a bell, notifying the terminal operator. The same operation turns on the terminal transmitter. A second ringing impulse from the telephone operator is transmitted to the train, where it rings a bell and turns on the transmitter, in the same manner as at the terminal. The procedure for calling in the opposite direction is similar. The train operator, after turning on the transmitter, operates the ringing key, which connects the ringing current with the transmitter. This is received at the terminal, operates the signal control circuit, turns on the transmitter and notifies the terminal operator. The same ringing impulse is received at the telephone exchange and notifies the operator to come in on the circuit. Both the terminal and train operators supervise the telephone conversation. The terminal operator can call and speak to the train operator or exchange operator if necessary.



A "TERMINAL" TELEPHONE EXCHANGE.
Communications with moving trains pass between an exchange on the train and a set called the terminal, illustrated above, which is housed in a building on the railway line.

The Wandering of Plants.

By A. C. Seward, Sc.D., F.R.S.

Professor of Botany in the University of Cambridge.

Darwin spoke of geographical distribution as " almost the keystone of the laws of creation " : he paid special attention to the means by which geographical distribution is effected, that is to the dispersal of plants by natural agencies. A recently published book on the dispersal of plants is considered by Professor Seward to be the most important contribution so far made to this subject.

ONE of the more obvious characteristics of the majority of plants as compared with animals is the lack of special organs of locomotion : a tree spends its life where the seed germinates. It is true that many plants with creeping stems are rapid colonizers of fresh ground ; but in a general sense it is only among the microscopical representatives of the vegetable kingdom which live in water that we find examples of motile forms. Trees, shrubs and herbs not only thrust their roots and branches through the soil and into the air, but the movements of their several parts are manifestations of response to various external stimuli. As a whole, however, most plants may be described as sedentary organisms. On the other hand, if we accept the conclusion that each species originally appeared at one place on the earth's surface, it is clear that plants are able to wander far afield. They can be carried bodily by such transport agents as wind, animals, and water ; or they produce fruits, seeds, or special detachable parts which, by virtue of various structural features or through power of resistance to desiccation, to the effects of sea-water or the digestive juices in an animal's intestine, can be carried longer or shorter distances from the stationary parent. Some plants are almost cosmopolitan and flourish equally well under very different climatic conditions ; others have a restricted range and are recorded only from a few localities on a continent or from a single island.

Geographical Range.

The geographical range of plants presents many problems : how can we account for the striking contrasts in distribution of plants which so far as we can see are equally capable of spreading ? There are many factors involved—competition, range of accommodation to different environments, relative antiquity, and others. Dr. Willis in his book " Age and Area " put forward the view that as a general rule the wider the range of a plant, or a collection of species of a genus, in space, the greater the antiquity. Dr. Ridley* shows that in many instances this cannot be adopted as a guiding principle. Many ferns which have now a restricted range are known to be closely allied to extinct species which were very widely distributed in former ages, while on the other hand, some of the common ferns of the present day appear to be relatively recent products of evolution It is obvious that the capacity of a plant to wander from its original home is closely correlated with the possession of fruits and seeds suitable for transport by wind, animals, or water. In other words, by the dispersal of plants, we mean the methods by which travelling is rendered possible : to some extent at least, the distribution of a plant depends for transport by natural agencies upon the suitability of the whole plant-body or of specialized parts which are readily detached.

Many Factors.

Dr. Ridley is primarily concerned with methods of dispersal, but he is fully alive to the fact that there are many other factors which determine geographical range. Readers of the " Origin of Species " are familiar with the emphasis given by Darwin to the question of plants as travellers, and the experiments and observations he made to test the efficiency of methods of dispersal. In one of his letters, Darwin wrote : " The hawks have behaved like gentlemen and have cast up pellets with lots of seeds in them " ; and in another letter to his friend, Hooker : " Hurrah ! a seed has germinated after $21\frac{1}{2}$ hours in an owl's stomach." He came to the conclusion that " during the vast geographical and climatal changes which have supervened since ancient times, almost any amount of migration is possible."

Everyone knows that spores of the lower plants, fungi, ferns, etc., and the seeds and fruits of many flowering plants, are blown long distances by wind by reason of their lightness ; that winged and plumed

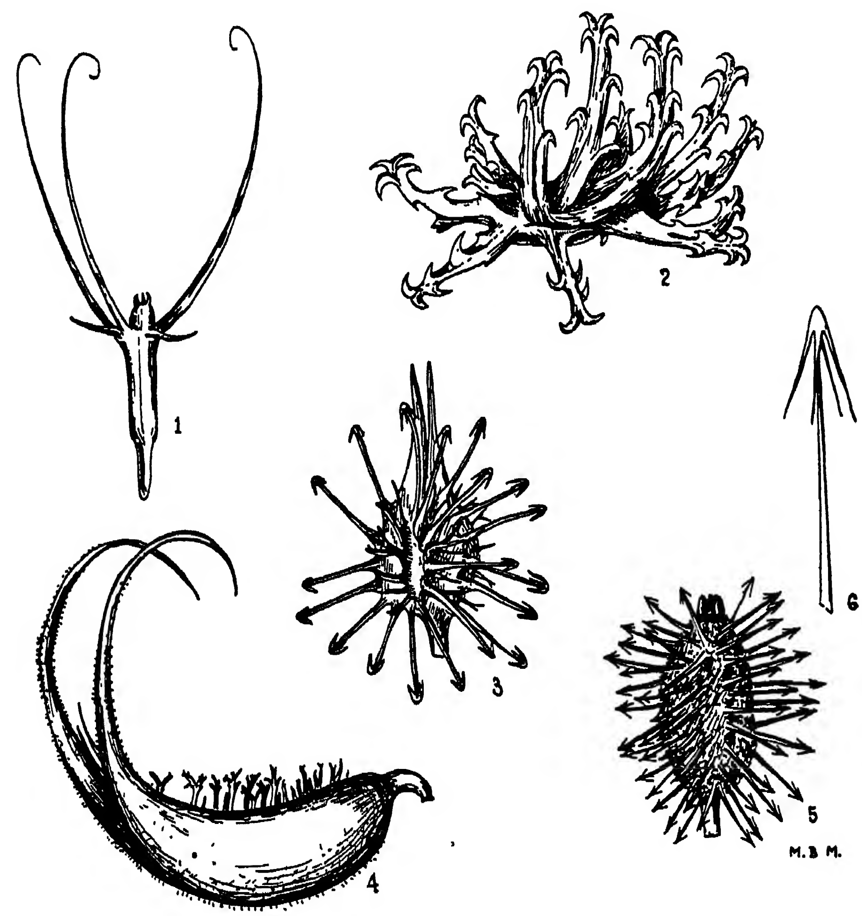
* " The Dispersal of Plants throughout the World." By H. N. Ridley, M.A., C.M.G., F.R S., late Director of the Botanic Gardens, Straits Settlements. (L. Reeve & Co. 63s.)

seeds are well adapted to transport by wind. It is also common knowledge that running water, whether the rain-wash on the slope of a bank by the roadside, a glacial stream in the Alps, or currents in the sea, carry smaller plants and the fruits and seeds of larger ones, it may be a few yards or it may be several hundred miles. It is a familiar fact that birds and other animals scatter plants either by eating the fruits and ejecting the seeds unharmed, or by acting as passive agents in the carriage of fruits and seeds adhering to fur or feathers. Botanical literature, books of travel, and letters in the Press provide innumerable instances of the ways in which travelling is accomplished. There is still much to be done by careful observation of the distances to which fruits and seeds capable of germination can be carried from the parent tree. One result of Dr. Ridley's untiring energy should be to stimulate naturalists, whether trained botanists or not, to make first-hand contributions to an exceptionally attractive subject.

There are endless possibilities: the colonization of ground recently laid bare, the use of aeroplanes provided with glass plates smeared with glycerine to catch spores or light seeds floating far above the ground; the collection of plants on the roofs of buildings, on pollard willows, or on the boughs of a tree felled in a tropical forest. Dr. Ridley gives many instances of plants bodily transported by the wind. He may be glad to have his attention called to an account of certain plants that are denizens of the sandy steppes, which Mr. W. R. Rickmers gives in his book, "The Duab of Turkestan": some of them, this writer says, are "like captive balloons anchored to the ground by a single root . . . many of these balls, often measuring six feet across, become detached when the winter gales are blowing. Bounding through the air, joining others and gripping them in tight embrace, forming gigantic spheres as they roll over the sand, they career through the howling steppe like ghoulish phantoms shrouded in their tunics of storm-swept dust, leaping fantastically to the shrill music of a thousand demons galloping through space on the manes of the wind."

It is clearly impossible to attempt even a brief summary of Dr. Ridley's life-work: his book is the most important and the most comprehensive contribution so far made to the subject of plant dispersal. He by no means confines attention to means of dispersal. An introductory chapter is followed by a series of chapters dealing very fully with dispersal by wind, by animals, by water and by other agencies; numerous references are given to original sources, and statements quoted are often subjected to criticism based on the author's personal observations. Attention is called to the fact that many plants, *e.g.*, the common reed (*Phragmites Communis*), the shepherd's purse (*Capsella bursa-pastoris*) and a host of others are not disseminated by one method but by several according to circumstances. While it is safe to assert that certain plants owe their dispersal to some one method, it is often impossible to say that such and such a species usually travels

(*Concluded on page* 408.)



FRUITS DISPERSED BY ADHERING TO ANIMALS.

This plate, reproduced from Dr. Ridley's book, shows (1) A Chinese and Japanese plant (*Trapella sinensis*) which grows in lakes. The spines on the fruit probably adhere to ducks, also, it is suggested, to fish and other animals. (2) A South African fruit (*Harpagophytum prostratum*) provided with strong recurved hooks. (3) A Madagascan fruit (*Uncarina peltatum*) which readily adheres to the skin or hair of passing animals. (4) The fruit of an American plant (*Proboscidea fragrans*) introduced with mule forage into South Africa during the Boer War. (5, 6) The fruit of a Rosaceous plant, *Acaena millefolia*, showing a complete fruit and a single barb.

A Footnote to the American Revolution.

By J. A. Benn.

Two record books of the late eighteenth century have been discovered recently at Princeton. New light is thrown on certain incidents in the Revolutionary War and also on university life one hundred years ago.

Few towns connected with the War of Independence have more interesting associations than Princeton, now famous for its university, one of the oldest in the United States. The College of New Jersey, as the university was originally called, was granted a Royal Charter in 1748 by George II, and was already a flourishing institution when the Revolution broke out later in the century. Situated half-way between New York and Philadelphia, Princeton lay naturally in the path of the opposing troops. The principal building, Nassau Hall, was used as barracks and hospital by the British and Hessians, and later by every passing body of American soldiers. Nearly ten years elapsed before the university authorities regained full possession of the building and could repair the damage caused by the war. During the decisive Battle of Princeton, on 3rd January, 1777, the Hall changed hands three times, the British troops who held it at dawn being driven out by Washington's victorious army, before the building was again reoccupied by the British during their retreat. The town continued to be prominent in the affairs of the new nation, and preliminary discussions on the Declaration of Independence took place within the university walls

A Dusty Vault.

It is not surprising that many historical discoveries have been made at Princeton. Old books and manuscripts, long forgotten in dark corners or on dusty shelves, are still sometimes found, and another discovery of this kind has recently been made in Stanhope Hall. Clerks engaged in cleaning out an old vault in this building found some books and papers of great interest relating to the Revolutionary period. The story is given in the university journal, the Princeton *Alumni Weekly*, to which we are indebted for the following details.

One volume is an account book of the Steward of Nassau Hall, concerned solely with Princeton, while the other is identified both with the Continental Navy during the Revolution and with the College of New Jersey from 1819 to 1827. This double connexion emphasizes not only the part Princeton played during the early days of American government, but also the financial straits in which the university found itself at that time, and which induced the authorities to make use of a discarded navy account book.

The Steward's Accounts.

During the early nineteenth century all undergraduates were required to take their meals at the refectory, which had recently been moved from the basement of Nassau Hall to a separate building where the Library now stands. The refectory was operated by the Steward of Nassau Hall, a title which persisted even after the location of the dining room was changed. The first of the books recently discovered shows the accounts of six Stewards, and covers the period from 1803 to 1817. It reveals the fact that the cost of board for everyone was a dollar and a half a week, except for divinity students, who were charged only a dollar. The money was usually given to the President of the College by the parents or students and was paid by him to the Steward, but there also are a few entries for direct cash payments. This book is of great value to the university because it lists all men in residence at the time. Accurate records have always been kept of graduates, but until about twenty years ago no concentrated effort was made to learn who were the non-graduates.

The second book is of even greater interest than the refectory ledger. It starts off as an account book of the Navy Board of the Middle District for the years 1780 and 1781. About half the pages were used in this way, leaving two or three hundred blank sheets in a neat, leather-bound volume. Somehow the book found its way to Princeton, and the hard-pressed university authorities, seeing its usefulness, appropriated it to record the circulation of the library. Because of the double purpose which it served, the book holds between its covers a record of the kind of reading engaged in by students more than a hundred years ago, and at the same time tells much of the story of the American Navy towards the end of the Revolution.

Before the establishment of a Navy Department, corresponding to the British Admiralty, the naval affairs of the United States were administered by a marine committee, with two subsidiaries known as the " Navy Board of the Middle District" (Philadelphia), and the " Eastern Board" (Boston). The long-forgotten book contains a record of certain business transactions of the Middle District Board for the years 1780 and 1781, with two back-entries for 1779. This period was one in which the American Navy met with reverses which reduced it from ten ships of war to three. The entries have to do chiefly with wages for officers, seamen, and marines, but the bold round hand of the Navy Board's scrivener has also left traces of a few more colourful items.

A Frigate's Adventures.

It is particularly interesting to trace in the accounts the fortunes of the frigate *Confederacy* from the time it sailed from Philadelphia in 1779, bound for Europe with a diplomatic party including John Jay and the French Ambassador Gerard, until it was captured in April, 1781. The vessel had proceeded half-way across the Atlantic on her diplomatic mission when she was unmasted by a storm. Unable to continue with safety, she headed for Martinique in the West Indies, where repairs from French allies might be expected. It was difficult to get suitable masts at Martinique, and the frigate was obliged to stay in port for six months. Jay, feeling sorry for the unpaid crew, advanced them money from his own salary—and three arrests for disorderly conduct and one duel promptly resulted! The diplomatic party eventually secured passage to Europe on a French ship, and the *Confederacy* returned to America with makeshift repairs.

The vessel lay in the Delaware River below Wilmington from May until November, 1780, waiting for the Navy Board to raise enough money to refit her, and when she was finally ready for sea the officers were obliged to resort to every legal and illegal means to replenish the crew, sadly depleted by sickness and desertion. There was a rendezvous before the ship sailed, and apparently music was resorted to for the purpose of securing enlistments. One of the entries in the ledger is: " To cash paid the Drummer and Fifer at the Rendezvous by Lt. Gregory"; and later " To ditto paid the Fiddler for playing at ditto by do." The Fiddler, the Fifer, and the Drummer, though they cost the *Confederacy* £60, were apparently unsuccessful, for later entries on the accounts of Captain Hardy and Lieutenant Gregory, the ship's marine officers, mentioned expenditures " for searching after deserters at Port Penn." This Delaware village was known in former times as " a resort of sailors and very immoral." Hardy and Gregory recaptured what deserters they could, but they had a new idea—that they might fill their ranks by offering to take deserters out of jail, satisfying the civil authorities by paying the turnkey's fees There are four entries of this sort.

In the book was found a scrap of paper with " These men came on board" and ten names scribbled on it. In those days to " come on board" might mean enlistment or it might mean a private party. It is known that at about the date mentioned on the scrap of paper ten men were impressed by the *Confederacy*, and it is quite possible these are the ones who joined the navy, but without the traditional enthusiasm for seeing the world. In one way or another the full complement of 260 men was made up, and the frigate dropped down the river. She made for the West Indies, having the good luck to capture a merchantman on the way. Her two months' stay at Cape Francois is attested to in the book by the entry " By cash received of Monsr. Lavand at Cape Francois, £450." This was possibly some share of the prize money turned over to the Navy Board by the French admiralty court in which the *Confederacy's* capture was tried.

While off the Delaware Capes on the return trip to Philadelphia the vessel was surprised and captured by two British ships, and was forced to strike her colours without firing a shot. The ship was taken to the harbour of New York; then in the hands of the English, her master was paroled, and a large number of the crew were sent to the rotting prison ship *Jersey*. This left the Continental Navy with but three vessels of war. One of these, the 28-gun frigate *Trumbull*, had suffered an unpleasant experience at the hands of the British the previous summer, and was still lying off Philadelphia being repaired as funds became available. The record of over £10,000 for labourers is probably for repair work on both the *Trumbull* and the *Confederacy*.

Currency Data.

A particularly interesting circumstance about the Navy Board accounts is that the depreciation of currency made it necessary to reckon the specie value of Continental money according to the date at which payment should have been made. Thus, for March, 1779, the paper was worth one-tenth its face value, in April, one-twelfth, and for all of 1780 and 1781 only one-fortieth. These rates of exchange are carefully figured out at each column total. Besides

the captain's accounts, there are entries in the book for several hundred marines who were with the two ships.

The most reasonable explanation of the book's subsequent appearance in the library of the College of New Jersey is that it was brought there when Congress, driven from Philadelphia by a mutiny of unpaid soldiers, spent the summer of 1783 in Princeton, holding its meetings in Nassau Hall. It is known that the library room, at present the office of the Graduate Council, was where Congress met. It is also known that one of the chief problems confronting Congress was the settlement of Revolutionary accounts, including those of the navy. There was at least one report during that summer by the Agent of Marine, and several committee meetings, and it would have been quite logical to have all accounts of the Navy Board there for the perusal of legislative committees. Six wagon-loads of documents were brought from the war office, and it is possible that what was true for the army might also have been the case with the navy.

When Princeton ceased to be the seat of national government the book was probably discarded, or simply overlooked. In any event, it served no useful purpose between the time of the navy entries and the year 1819, when it was appropriated by the university librarian to keep track of borrowed books. Each student, faculty member, and administrative officer was given a column, at the head of which was written his name. Then, in the order in which they were borrowed, is a list of all books taken from the library by that individual The record was kept in slovenly fashion, in marked contrast to the naval accounts, but in almost all cases it is possible to decipher the titles, and in this way to arrive at a fair estimate of the sort and quantity of reading indulged in by these early students.

Famous Names.

Of special interest are the columns allotted to certain men who later became famous as educators, statesmen, and in other walks of life. The names of three United States Senators and a Secretary of War are included. Of all those mentioned in the book, the man most intimately connected with it is John Maclean, tenth President of Princeton. In 1816 he graduated at the age of seventeen, and with the exception of the next two years the rest of his life was devoted to the university. The book, covering as it does the period from 1819 to 1827, includes the years in which Dr. Maclean was successively tutor, clerk of the faculty, and professor. As far as the records show, he borrowed about ten books a year from the library, but when it is noted that these invariably included two or three volumes of an encyclopaedia it will be clear that this is no reflection on the amount of his reading. In the course of his long connexion with Princeton, Dr. Maclean at one time held the office of librarian. A loose paper discovered in the book refers to this appointment and affords further evidence of the authenticity of the volume, which throws such interesting light on the conditions of university life in America a hundred years ago.

The Best-read Man.

Judging only by library circulation, the best-read man was Luther Halsey, professor of "Natural Philosophy, Chemistry, and Natural History." By early training he was a theologian, but he kept in touch with scientific developments, and we find him in 1823 reading not only philosophy and *belles-lettres*, but also books on electricity, mineralogy, and other subjects that were unknown to most of his countrymen. He acquired a considerable reputation as a preacher and orator, and it is possible that we are eavesdropping on the preparation of one of his speeches when we note the following books taken from the library on a certain 3rd July: "Gordon's Revolution, Socinian Controversy Letter, Johnson's Green, United States Gazette for 1789, Dodd's Commentary, Guard's Pastoral Care, and the Bible of Martini."

Other members of the faculty engaged in scientific reading, but none of the undergraduates seem to have taken any interest in subjects that were apparently as remote from their understanding as theories of the fourth dimension are from the average student of to-day. There was not a great deal of difference between the reading of divinity students and the others. Cooke's "Voyages" seems to be the most radical literature known at the time, and it was a lucky man who could take a volume of an encyclopaedia home with him.

Many columns reserved for the students are innocent of a single record of book-borrowing, though in some cases the thrifty librarian merely crossed out one name and wrote another in its place. There is one case of three McCormicks who graduated from Princeton in 1820, 1822, and 1824. Apparently, the first had borrowed no books by the time the second one entered two years later, so his first name was crossed out in favour of the newcomer's. This second McCormick took out no books, and the name of the third was written over the other two. He retrieved the family reputation by filling the column!

Research in the Linen Industry.

By W. H. Gibson, O.B.E., D.Sc.

Director of the Linen Industry Research Association.

An exhibition is now on view in London to illustrate the progress of the linen industry, of which the recorded history dates back 7,000 years. Extensive research is being undertaken, but many problems still await solution. The largest photo-micrograph in the world is among the results of this new work.

THE linen industry was among the first of the large industries to form a Research Association under the scheme formulated in 1917 by the Department of Scientific and Industrial Research. The object was to establish in the framework of the industry a permanent institution facilitating by its researches and advice the general welfare and development of all branches of the industry. Research and discovery by individuals still continue, but their work is now supplemented by co-operative effort. At the present time, the Association has staged a comprehensive exhibit at the Science Museum, South Kensington, to demonstrate the ramifications of the linen industry and the scope for research work which exists within it.

FIG. 1

SPIRAL STRUCTURE OF FLAX FIBRE.

Microscopic examination shows that each flax fibre is built up of fibrils, about one-millionth of an inch in diameter, arranged in right-handed spirals

The general plan of the exhibition is to give in the first section a survey of all the processes of linen manufacture, from the sowing of the flax seed by the farmer to the final examination of finished linen articles before shipment to the consuming markets This is followed, in the second section, by examples of the application of research to these processes, and the third section consists of examples of typical finished products of the industry. In this way it is hoped that the visitor without specialized technical knowledge will be able to realize the meaning of the various investigations and the value they have not only for the industry but for every user of linen.

It will be recognized that in the case of a well-established industry like the linen industry, with a recorded history of over 7,000 years, the requirements of the user must already be met in a way to afford a high degree of satisfaction. It cannot therefore be expected that changes to revolutionize the finished product will be suggested as the result of further scientific investigation and discovery. The first step is to secure a better understanding of linen and its processes of manufacture, in the expectation that this must lead to ways of making an already attractive article rather cheaper and considerably better. Accordingly research during the past ten years has followed three broad lines: (*a*) the study of the flax plant as the source of raw material; (*b*) the critical study of manufacturing processes in detail with reference to the effects they produce upon the linen fibre; (*c*) the study of the properties of the finished linen fabrics and other goods.

The structure of the flax plant has been very thoroughly investigated by microscopic methods. It is found that in a single flax stem of good fibre quality there may be 25,000 individual flax fibres, averaging one-thousandth of an inch in diameter. Their cross-section when magnified is an irregular polygon with a small central cavity. Further treatment with alkalies and pressure before microscopic examination of the individual fibre under high magnification, shows that it is built up of fibrils, about one-millionth of an inch in diameter, arranged in right-handed spirals. This structure is shown in Fig. 1. On account of this spiral structure it has been found that when a flax fibre held vertically at

the lower end, dries after moistening, the free end twists in a clockwise direction. This, as it depends on the intimate internal structure of the flax fibre, has proved to be a reliable method of distinguishing flax in any stage of manufacture from a similar fibre, hemp, as the latter has the reverse character.

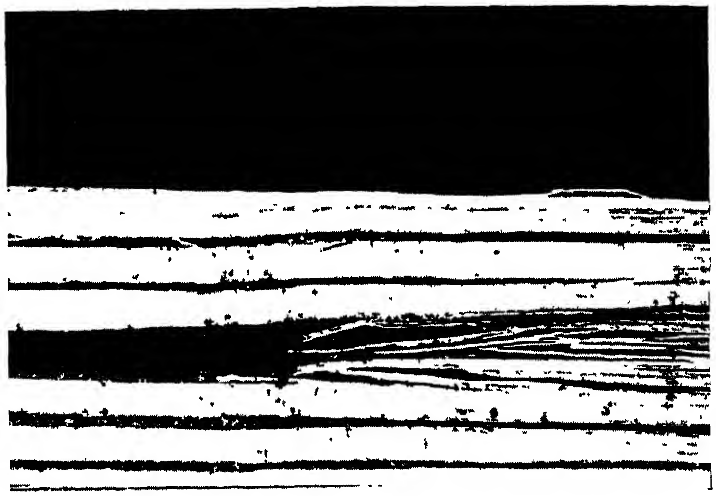


Fig 3
PHOTO-MICROGRAPH SHOWING LEAF-TRACE
This section is part of the largest photo-micrograph in the world, and shows a strand ending at a leaf-trace The parallelism of the fibre strands is worthy of note

The fibre arrangement in the cross-section of a flax stem is seen in Fig. 2. It will be noticed that the flax fibres are found embedded in a layer of soft bast tissues surrounding the inner wood, and outside them a coat of waxy tissues forms the skin of the plant. The individual flax fibres in groups of about thirty form distinct bundles which are the fibre strands of the flax spinner, and there are about thirty bundles or strands passing through the cross-section. These structural arrangements in the flax stem have a bearing upon the strength and quality of flax fibre as yet not fully understood. The cross-section of the flax stem has been chosen as the principal test-piece in determining the selection of flax plants for pedigree strains. For this reason the technique of cutting sections of this very tough material in celloidin has been thoroughly developed. Over 12,000 perfect sections, less than one-thousandth of an inch thick, have been cut and measured during the ten years of this plant breeding work.

The arrangement of the bundles of fibres lengthwise in the stem has been studied with similar thoroughness by photo-micrographic methods. A single flax stem was taken and, after suitable treatment, a slit was made through the outer skin and the fibre layer from the tip to the root along one side of the stem. The curved ribbon containing the fibres was then detached from the inner core of wood and placed flat upon a long glass strip and mounted in the usual way. Photo-micrographs were then taken at a magnification of about 30 in polarized light along the whole length of the strip. From these, some 700 in number, the complete photo-micrograph of the fibre structure of the flax plant was built up. It measures 60 feet by 9 inches, and is the largest photo-micrograph in the world.

The fibre arrangement disclosed by this photograph shows that the bundles or fibre strands may extend the whole length of the stem, but that at every leaf-trace, where a leaf emerges, a fibre strand ends. This explains why a greater amount of tow or short fibre is removed in combing flax with fine pins from tip to root than from

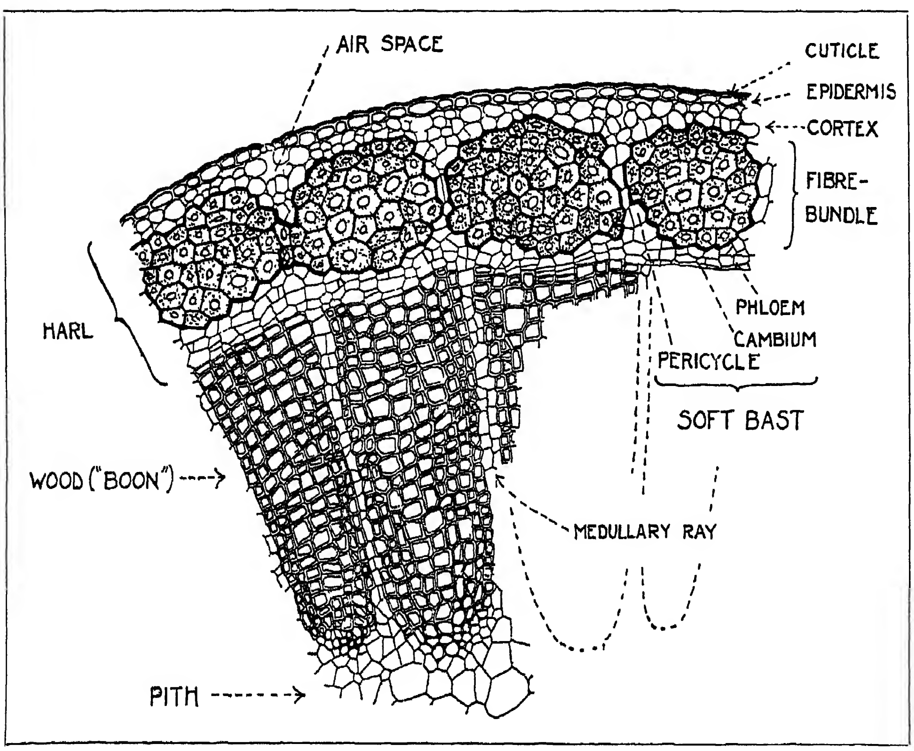


Fig 2.
CROSS-SECTION OF A FLAX STEM.
The structure of the flax stem has a bearing on the strength and quality of flax fibre not yet fully understood.

FIG 4.
A CROSS BETWEEN TWO FLAXES.
The selected hybrid is in the centre and the two flaxes which were crossed are shown on each side, the male on the right and the female on the left

root to tip, since the pins catch the ends in the first case but slide past in the second. A short section of this photo-micrograph is shown in Fig. 3 with a strand ending at a leaf-trace. The parallelism of the fibre strands in the plant is also worthy of note as this is favourable to the subsequent operation of spinning.

The cultivation of the fibre flax crop during last century tended to decrease in western Europe but was maintained by the Russian peasant. This neglect by the advanced agricultural peoples probably accounted for the few genetical studies made of the plant. This has been remedied to a considerable extent during the past ten years. Inherited characters of the flax plant have been identified and strains of flax selected or bred possessing these inherited characters to a greater or less degree. Naturally, those characters which influence the yield of fibre to the flax grower and the quality of fibre for the spinner have received most attention. It was fairly easy to establish that tallness and early ripening were heritable characters, and by selection for height the yield of flax was increased by fifty per cent.

The development of the method of section cutting and measurement afforded proof that the fibre content of the flax stem was heritable, and this has led to strains with an increased fibre content of about thirty per cent and increased yield to the flax grower of about 100 per cent. Quality is more important to the spinner, but here also genetical study has led to a variety of approximately twenty per cent better quality, other conditions being equal. Fig. 4 shows a descendant, the result of a cross of two flaxes differing in height and fibre content shown on either side.

The botanical investigation of the flax plant has proved definitely that the flax fibre bundles or strands exist in the plant in a parallel arrangement, and study of the spinning processes shows that this parallel arrangement is demanded for good spinning. It follows that investigation of the processes of detaching the fibre strands from the flax stem in order to secure the maintenance of parallelism most efficiently is of great importance. In the past this has been secured by the exercise of a very high degree of manual skill, particularly in Belgium, in harvesting, retting, and scutching the crop, but at the present time research is directed to the mechanization of these processes to the greatest possible extent and subject to the condition that effective parallelism must be maintained. Work is now being done upon these processes in a factory capable of dealing experimentally with the flax crop from about thirty acres. The scientific control of the bacteriological process of loosening the fibre strands from the stem is one matter that has received much attention.

In the operations in the spinning mill prior to spinning, the fibre strands are arranged in an endless ribbon, and this ribbon is successively drawn fine and doubled with other ribbons to secure a very fine, uniform ribbon. Scientific investigation here has taken the form of intensive study of the dimensional changes which take place in the fibre strands, and a special machine has been devised, the fibre sorting machine, for the statistical analysis of the strands at all stages of the processes. In the spinning operation itself the ribbon of fibres is drawn still finer and then twisted, this method giving linen yarn.

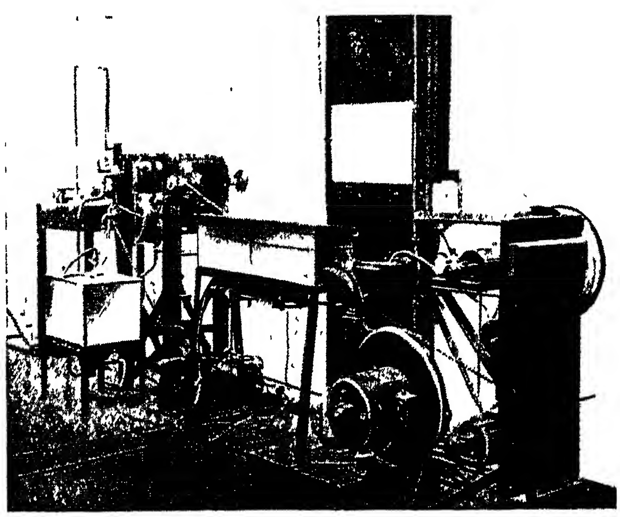


FIG. 5.
THE WARP DRESSING MACHINE.
In this machine all the conditions of tension, speed, and rate of drying of the yarns are controllable. The yarns are dressed with a starch mixture.

Investigations are mainly directed towards securing the greatest degree of levelness in the yarn and of regularity in the twist imparted to it. The measurable properties of yarn, such as tensile strength, resistance to wear and extensibility, are related to levelness and twist. The autographic recording machine traces the load-stretch diagrams for yarn.

In the process of weaving the yarn to be used as warp is wound in parallel form upon the beam. These yarns are then dressed with a starch mixture to protect them during their passage through the loom when the weft threads are interlaced to form the fabric. This process has been investigated by means of the experimental warp dressing machine illustrated in Fig. 5. In this machine all the conditions of tension, speed, rate of drying of the yarn and mode of application of the dressing are controllable, and their effect upon the degree of the protection afforded may be ascertained. The line of approach to research on the loom has been to observe the effect of every action of the loom upon the yarn passing through it, by means of suitable tests which have had to be devised.

The study of the chemical constitution of the flax plant has proved to be difficult but of great interest. The clean flax fibre obtained from the harvested flax straw is a silky lustrous material of a pale cream colour, not susceptible to the attack of retting bacteria, but of complex composition. The non-cellulosic portion is made up of a hemi-cellulose very firmly fixed to the cellulose and a smaller percentage more weakly linked, possibly by a glucoside linkage.

Bleaching Problems.

The chief problem of the bleacher, however, is to deal with extraneous matter derived from the outer skin of the flax stem. This again is complex in nature, containing up to ten per cent of a wax similar to beeswax in chemical and physical properties and a cutinized cellulose. The use of bleaching powder and alkaline hypochlorite by the bleacher has required work on the composition of hypochlorites under different conditions of concentration and reaction. This has resulted in careful control of the processes of bleaching.

In dyeing linen the fast dyes of the vat class are principally used, and special study of their application to linen has been necessary to obtain even penetration. The finishing processes on linen are controlled by study of the optical properties of fabrics, such as lustre, transparency, whiteness and colour. Optical instruments of a specialized type are used.

The culmination of all the research work is the study of the properties of linen fabrics in relation to their different uses. Various tests are used as measures of durability and of resistance to laundry wear. Studies of this kind influence the design and specification of fabrics for various purposes and lead to investigations too numerous to mention here. It has only been possible to deal with a few of the exhibits within the limits of this brief review, but it is hoped that readers will feel impelled to take this unique opportunity of visiting the Museum and of becoming familiar with the linen industry and the scientific research connected with it.

The Wandering of Plants.

(*Concluded from page* 401.)

by one particular kind of conveyance. Much valuable information is given on distribution, on the range of form and structure and adaptive characters within a single genus, on possible lines of evolution within a genus or family. In several places, the author uses language which lays him open to the charge of assuming purpose in evolution: he speaks of colours of fruits as " destined to attract the attention of birds "; but, as Dr. Stapf pointed out some years ago, there is " no proof that a fruit which is fleshy and presumably attractive to birds is eaten by them or dispersed by them." In another place Dr. Ridley writes: " The various forms of fruit which we see throughout the vegetable kingdom have been entirely evolved with a view to the dissemination of the seedlings." Dr. Guppy, one of the leading authorities on plant dispersal, expressed the opinion that " nature habitually makes use of structures and capacities that were originally developed in quite another connexion."

There are twenty-two plates with good drawings of fruits and seeds illustrating different means of dispersal; they would be more useful if the scale of the drawings were given. It is no doubt impossible in a book of this kind to avoid repetition, but I venture to think that some condensation might be effected when a second edition is required. There is a most useful bibliography. One wishes that a standard book of reference such as this could have been published at a lower price; it is a volume which will long remain indispensable to botanists and others interested either in plants as travellers or in the numerous animals which serve as carriers. Dr. Ridley has earned the gratitude of his fellow naturalists—few, indeed, have a knowledge of animal and plant life equal to his—by the completion of a gigantic undertaking, which must have been also a labour of love, in the busy years since he retired from the directorship of the Singapore Gardens.

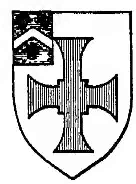
British Universities To-day : (10) Durham.

By Sir Theodore Morison, K.C.S.I., K.C.I.E., D.C.L.

Formerly Principal of Armstrong College and sometime Vice-Chancellor of the University of Durham.

Durham is the oldest of the provincial universities of England and will celebrate its centenary in 1932. The University was founded by the liberality of the Dean and Chapter of Durham but owes its later development to the sympathy and support of the great industries on Tyneside.

In 1832, between the tumultuous debates upon the great Reform Bill, the Bishop of Durham laid before Parliament a bill to establish a university in Durham. The oligarchic mould in which English society had rested peacefully for so many centuries was just then beginning to crack ominously, and the good bishop must have heard some wild talk of which he thoroughly disapproved, but he certainly had no intention of introducing a measure which would alter the existing structure of society. The statement which he made in the House of Lords was that the Dean and Chapter of Durham were prepared to surrender property worth £100,000 for the purpose of endowing chairs of divinity, ancient literature, and mathematics and readerships in such other branches of literature and science as might be required. Durham, his lordship thought, was eminently suited to be the seat of a university because it possessed well furnished libraries and buildings that might be used for teaching and for residence.



A Medieval Setting.

If the bishop intended to reproduce in the north of England the medieval atmosphere of Oxford, he could not have found a town more apt to his purpose than Durham. High on a rock round which the river Weir throws a fantastic loop towers the massive cathedral, the finest piece of Norman architecture in Europe. Opposite, on the northern slope of the rock, stands the bishop's palace or castle, the fort which protected the Palatinate against Scottish invaders ; between the cathedral and the palace is an open space, which out of deference to its ecclesiastical surroundings should be called the Close, but as it was obviously the parade ground on which the Prince Bishop reviewed his troops it is known as Palace Green. The old town climbs the castle hill, and its winding streets and narrow alleys are still suggestive of the Middle Ages. It was natural that the Bishop of Durham should think that this was a suitable site for a university which should, like Oxford, devote itself principally to the training of Anglican clergymen.

The only incident which disturbed the passage of the bill through the House of Lords was an audacious question from " Radical Jack " (as his enemies called Lord Durham), who wanted to know whether dissenters would be admitted to degrees in the new university. This, of course, was wholly out of the question. The promoters of the bill had framed the constitution of the university, they averred, with the greatest liberality , dissenters might attend lectures without being members of the university, if they became members of the university they must, of course, submit to the internal discipline prescribed and attend church service daily ; no religious tests would be imposed at the time of admission on those who might become members of the university, but only on those on whom a degree might afterwards be conferred. Obviously the Episcopal Bench was not contemplating any considerable alteration in the social structure of England, but the university which they founded was destined to develop tendencies at which they would have stood aghast.

In that same year, 1832, the medical profession in Newcastle-upon-Tyne founded a school of medicine and surgery, which twenty years later was associated with the university and which in 1870 was formally recognized as the seat of the medical faculty and named the University of Durham College of Medicine. In 1871 a more serious departure was made from the conception of the original founders. By the joint efforts of the University of Durham and the North of England Institute of Mining and Mechanical Engineers, a college was founded in Newcastle for the teaching of physical science, which assumed the name of Armstrong College in 1904. This was intended to be the faculty of science in the university.

At a time when England was groping uncertainly after a constitution for her younger universities, Durham evolved the ingenious idea of allocating different faculties to institutions in different localities, a device by which it was hoped to reconcile local

ambitions with central control; thus the faculty of science was to be placed in Armstrong College, the faculty of medicine in the College of Medicine in Newcastle, and the faculties of theology, ancient literature and music were to have their seat in Durham. This distribution of academic functions seemed to square very well with certain patent facts. Newcastle was the centre of the mining and engineering industries on the north-east coast, and their directors were becoming increasingly anxious for the assistance which science might give to industry; they therefore wanted the scientific teaching of the university to be given in Newcastle; the doctors on their part could point out that the faculty of medicine could not be separated from the Royal Victoria Infirmary, which provides perhaps the finest clinical material in England, and there seems an evident appropriateness in teaching divinity and the learned tongues beneath the shadow of the ancient cathedral.

But though this allocation of faculties seemed to correspond with the geographical distribution of interests, it was academically unsound and it has failed to endure. Learning is one; it cannot be departmentalized; owing to the shortness of life a certain degree of specialization is inevitable, but no scholar can cut himself off from the workers in other fields without peril. The pioneers of science who were in the 'seventies making so rich a contribution to English thought, were sometimes led to think that physical science could be sufficient to itself and needed no contact with the humanities. But the history of knowledge since their time has shown that it was their method rather than their special subject which was illuminating, and their method has since been applied to such borderline subjects as economics, psychology and anthropology, which brings us close to the confines of the faculty of arts. Armstrong College soon found that young men and young women could not be nourished on a diet of science only; departments of English, classics, history and philosophy were added, and in 1909 its students were admitted to degrees in arts.

Art and Music.

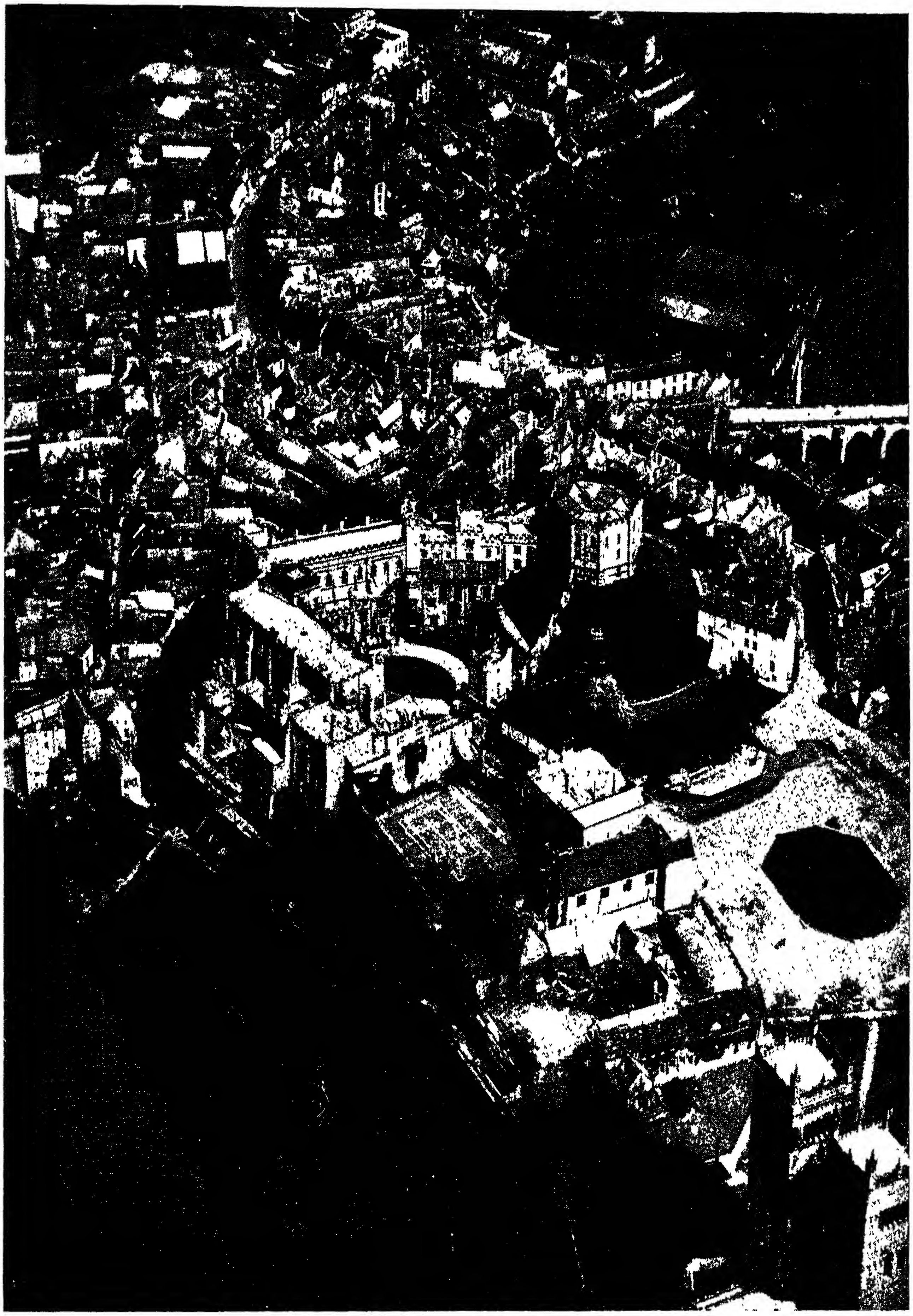
It is interesting to note that it is that college of the University of Durham which was founded with the object of teaching science exclusively which has in later years taken the broadest view of educational culture. As long ago as 1888 the Newcastle School of Art was united to the college and formed the nucleus of a regular department; and now both fine art and music are the subjects which students of Armstrong College may present for the degree of B.A.

In an industrial area like Tyneside the technological aspect of science has from the first commanded the sympathy of the council of the college. A department of mining was established here before such teaching found a place in any other university in England, and from its foundation this department has kept in the closest touch with the industry. To this day the output of coal in the northern counties is carried out very largely under the direction of former students of Armstrong College. Two years ago the efficiency of this department was greatly increased by the erection of a fine building devoted solely to teaching and research in mining engineering. The cost, amounting to over £30,000, was supplied by the Central and Northumberland Miners' Welfare Committees, an interesting proof that both the masters and the men engaged in coal mining are convinced that it is only by the application of science to their industry that the northern coalfield can regain prosperity. When the Prince of Wales opened the building he took care to drive that lesson home.

The Science of Ships.

Shipbuilding is another industry upon which the wellbeing of the Tyne valley largely depends, and for this reason there has long been a chair of naval architecture in Armstrong College. When Professor Welch retired from that chair in 1928 the college took counsel with the great shipbuilding firms as to the further maintainance of this costly department. Economic depression had lain heavily for eight years upon the Tyne yards, but the shipbuilders replied unanimously that they could not do without a professor of naval architecture in Newcastle, and one of the directors of the honoured firm of Hawthorn, Leslie & Co. undertook the task of securing subscriptions from this much depressed industry to support the continued teaching of this subject. His exertions were crowned with such success that the continuation of the department was assured, and at the suggestion of the shipbuilding firms on the Tyne Sir Westcott Abell was appointed to fill the vacant chair.

Armstrong College has other departments of applied science: agriculture, electrical engineering and mechanical and marine engineering, in all of which Northumberland and Tyneside are deeply interested. The intimate association of these scientific departments with the relevant industries was illustrated recently by an inquiry conducted jointly by the college and the North-east Coast Institution of Engineers and Shipbuilders upon the proper training of an engineer. It was common ground to the two



Aerofilms

DURHAM UNIVERSITY FROM THE AIR

parties of the inquiry that (1) an engineer needs a severe training in scientific principles which he can best acquire at a university; and (2) that a university cannot give the practical experience and exercise of responsibility which is indispensable for the direction of engineering in the field and the workshop. The report subsequently published by the Institution established the lines on which an engineer should be trained, and is a document of permanent value to a great profession not only in the north of England but throughout the Empire.

Three Colleges.

The University of Durham thus consists of three constituent colleges, of which two, the College of Medicine and Armstrong College, are situated in Newcastle, and one upon the cathedral hill of Durham whence the University derived its appropriate motto, *Fundamenta ejus super montibus sanctis.* Like Oxford, the Durham division of the university consists of a number of residential colleges, University College, Hatfield College, St. Chad's College, St. John's College, etc., which for academic purposes are grouped together under a council. A distinctive feature of the Durham division is the residential system inherited from Oxford and Cambridge, which has been jealously maintained and which has constituted one of the most important contributions made by Durham to university education in the nineteenth century. Of the 466 students now in this division 97 per cent reside in colleges under the usual college discipline. For many years the principal activity of the Durham division was devoted to the training of candidates for Holy Orders, but while Armstrong College in Newcastle was spreading out into so many new fields of education it was impossible for the Durham Colleges to remain long satisfied with a curriculum confined to divinity and arts. Within the last five or six years they have obtained from the university permission to prepare students for degrees in pure science, and have erected outside the precincts of the ancient city a block of laboratories for teaching chemistry, physics, geology and botany—a building which by its architecture seems designed to mark Durham's emancipation from the medieval tradition.

The expansion of the curriculum and the erection of new buildings are evidence of the healthy progress and development of the university, but they are of interest principally to academic specialists. What is of far greater importance and of national interest is the change in the students since the foundation of the university. In 1832 a university education was still the privilege of the governing classes; Oxford and Cambridge were reserved for the sons of gentlemen and would not, in those days, have been ashamed to avow it. There were then, as there have always been, plenty of poor men in the old universities, but they too belonged by birth and tradition to that relatively small class which did in effect govern England. After taking a degree they passed into the learned professions or into the service of the State and provided the controlling staff of the old order of society. When the Dean and Chapter proposed to found a university in Durham they contemplated nothing more than a new centre in the north of England for educating this governing class. But in less than a hundred years the students of the university have changed beyond recognition; they now come in large measure from a stratum of society in which in those days the possibility of a university education was never contemplated. In Armstrong College something like 50 to 60 per cent of the students come from working-class homes. There are there sons and daughters of miners, riveters, fitters, postmen, police constables and railwaymen They started their education in elementary schools, passed with free places into the secondary schools maintained by county councils, and from there they won leaving Scholarships which enabled them to read for three years at the university. In the springtime of life when they are most receptive of new impressions they pass into a larger world; books, music, and even pictures are there in abundance, playing fields for the athletes, and the debating hall of the Union for the orators. Best and most educative of all is the society of a number of eager young persons of their own age, with whom they discuss everything: religion and sport and politics, the merits of the German film and the prospects of Empire trade.

The Students' Council.

How does the son of a miner from a pit village bear himself in this new world? Exactly like a freshman in any university. College life is eminently democratic. Personality tells and nothing else. In two years in succession sons of miners were elected to the position of president of the Students' Representative Council in Armstrong College. And the S.R.C., as it is called, is a body with considerable powers over the student world; it apportions funds between the different clubs and societies and makes rules which are effectively binding. When a young man passes out of the university, after having for three or four years taken his full share in the social and intellectual life of his college, he will bear himself worthily in any walk of life. If he is a man of first-rate ability he may rise to the top

of any profession. And, in fact, all professions are now open to him. First-rate ability is so rare that in a competitive world it never fails to find a market. Students of Armstrong College, of whom alone I can speak from personal experience, are now passing into government service, the professions, and into industry.

Intellectual Aristocracy.

In twenty years time those of them who have real ability and character will rise to positions of command; they will form part of that intellectual aristocracy which in different spheres directs the fortune of England. This is the social revolution which the Bishop of Durham unconsciously set in motion in 1832. It is a consummation which he probably did not wish, for he lived in a world which was then stratified in super-incumbent classes, to each of which was assigned its appropriate duties. The world which these young men are making will be one from which the distinction of classes will have disappeared, and with it, we may hope, much of the bitterness and jealousy which still disfigure English life.

I have spoken of curricula and buildings and students; what of the dons, proctors and principals, the potent, grave and reverend signiors who control all this young life? Do they live in the past or present? Do they think the thoughts of the nineteenth or the twentieth century? In what spirit are they preparing the young men and young women of to-day for the dangers and difficulties which lie before them? I can best answer those questions by quoting one passage out of the address given to the students at the beginning of this session (1930-31) by the Principal of Armstrong College :—

" Our aim is to turn you out from Armstrong College as good citizens. I will not enlarge on all the qualities which that requirement demands; the qualities of accuracy, thoroughness, clear thinking, comradeship, broadmindedness—all these are involved; and I hope and believe that your sojourn here and your activities both in the lecture rooms and outside them will do much to cultivate such merits in you. But, necessary and valuable as they are, these may all be called the, relatively, static virtues. I suggest to you that in these days of depression and uncertainty like the present what the country chiefly needs, what perhaps we all need for our souls' good, is something more dynamic.

There is no one easy word for the virtue which I have in mind; it is not recklessness; it is not disregard of principle; it is not a denial of well-proved truths; it is certainly not that feverish seeking of pleasure and excitement of which one sees rather too much to-day. It can be distorted or perverted into all or any of these; but they are really corruptions of it, and the thing itself is the good element in all of them. In a word, I am thinking of a willingness to take risks, to tread untrodden ways, to pioneer, to push out into the unfamiliar: the spirit of the spacious days of Elizabeth, of Drake, Frobisher and Raleigh. As we know that spirit is still alive in the twentieth century. A year or two ago it cost us two lives within a few hundred feet of the top of Mount Everest; and within the past few days it led fifty brave men to a terrible death in France. It animated the heroic ladies who have recently been murdered in China. But it also carried Lindbergh triumphantly across the Atlantic and sustained a brave lady successfully on her solitary flight to Australia. We should not make the mistake of judging the value of the effort by its success or failure. The great thing is that men or women were found ready to take risks; to adventure not knowing what the end would be, but willing to risk failure for the joy of doing and the sweetness of success.

I say that we need such a spirit as a people if we are to heave ourselves out of our super-incumbent troubles. Perhaps the wonder is that its manifestations are as rare as they are. We are inclined, and I think justly, to ascribe most of our worries and disillusionment to the Great War and its appalling consequences. There have been very critical times before now in human history. Think of the Greeks at Salamis, think of the Spanish Armada, think of France in the first flush of the Revolution, or the Americans after York Town or Britain after Waterloo. These were all instances of men fighting in some great cause, which at one time seemed almost hopeless and yet in the end was triumphant. Read the history of the days which succeeded such triumphant effort; and whatever shadows darken parts of it, you cannot but see that men and nations were for some time, in the best sense of the word, 'above themselves.' They felt their powers in an unusual degree. They respected themselves more. The air was brisker, the sun was brighter, men trod the earth more lightly. There was a feeling abroad of untried possibilities and a confidence that with effort nothing was impossible

Why cannot we have that feeling now? . . . Some of the reasons may be obvious enough. I suspect, indeed, that one thing lacking is the right prophet, and I believe that he will come in time. But I do feel sure that the remedy of our discontents and burdens can come only with a certain change of spirit, and I want to urge upon you to do what you can to bring that change about by cultivating a spirit of adventure and exploration."

A Call to Adventure.

This is a virile doctrine expressed with dignity and precision. The Viking blood which is believed to run in Northumbrian veins should tingle to such a call to adventure, and, indeed, the spirit which the Principal of Armstrong College evoked will be needed throughout England if the generation which is now growing up is to fight its way through the difficulties with which it will be confronted. Great changes there will certainly be, our staple industries may decay and new forms of competition may threaten our trade; but machinery and equipment are matters of secondary importance; as in the days of the sailing ships it's the man behind them that matters. The business of the universities is to see to the soundness of the human material on which the issue of the struggle will depend.

Curiosities of Bird Life in Burma.

By Cyril Hopwood.

Formerly of the Imperial Forest Service.

The discovery of the masked finfoot's nest is among the important finds described in this interesting study of Burmese birds. The author was responsible for taking the first eggs of this rare Eastern bird, and thus enabled ornithologists to arrive at a classification which had long been a matter of considerable doubt.

THE Province of Burma extends from the twenty-eighth to the tenth parallel of north latitude, and is essentially a forest country. In fact, more than half the area is under timber, and the altitude ranges from sea level to a height of ten thousand feet. As may be readily imagined, these factors combine to render it a veritable paradise for the ornithologist. During a period of twenty-eight years spent in Burma, the greater part of the time in the Forest Service, I had ample opportunity for making a close study of the birds of the country, and devoted all my leisure to this fascinating occupation, paying special attention to the breeding habits of the rarer and less known species.

In pursuit of these investigations, I was singularly fortunate in that my work took me to some of the wildest and least explored parts of this vast area during the height of the breeding season, which may be taken roughly as being from March to June, although, as is the case in all tropical countries, certain birds are found breeding in every month of the year. This may be conveniently divided into three seasons: the cold weather from the end of October to February, the hot spell from the beginning of March to the end of May, and the rainy season from June to October. The breeding "year" appears to start with the turn of the season in October, when such birds as pelicans and the various storks commence nesting operations, closely followed by the eagles and some of the hawks. Towards the end of the cold weather, in February, the passerine birds, which comprise about sixty-five per cent of the total, start nesting, and from March onwards the bulk of the terrestrial birds are breeding. The waterfowl, such as cranes, non-migratory ducks and rails, commence to breed about July and continue until the end of the rainy season.

THE ETERNAL EVERGREEN.
In the forests of Burma many of the rarest birds are found, and it was here that the author discovered the nesting-place of the black jay.

Of over twelve hundred species which have been recorded as inhabitants of, or visitors to, Burma, few are of greater interest than the parasitic cuckoos, of which about a dozen different species are more or less common in suitable localities. Foremost is the eastern race of the common cuckoo, which occurs as a breeding migrant in the hill country at elevations of three thousand to five thousand feet, and arrives in Burma during April. The bird differs from the European race only in minute technical details, and its habits are identical with those of the bird so well known in England.

Mr. Edgar P. Chance published the record of his work on the cuckoo some years ago under the title of "The Cuckoo's Secret," and in April, 1928, Mr. Oliver Pike contributed to *Discovery* some further interesting facts. My own observations of the eastern

bird entirely corroborate all that these two keen naturalists have recorded about the western variety, but the birds which breed in Burma appear to differ in laying a much smaller egg, and one of a constantly light colour, rather resembling that of an English robin. Further, the hens are far less prolific than is the case in England, although this does not apply to the same bird in India, which certainly can produce the eight or nine eggs, which are considered a fair average for the western race. Probably the commonest, and certainly the noisiest, of the parasitic cuckoos in Burma is the handsome red-winged crested species, a denizen both of the hills and plains, which victimizes the laughing thrushes. It lays a pure blue, rather spherical egg, matching those of its victims in colour, and I have often found two, and once three, eggs of this cuckoo in laughing thrushes' nests.

A NEST SEVEN FEET LONG
This sketch by the author shows the nest of the dus[illegible] broadbill. It was no less than seven feet in lengt[illegible]

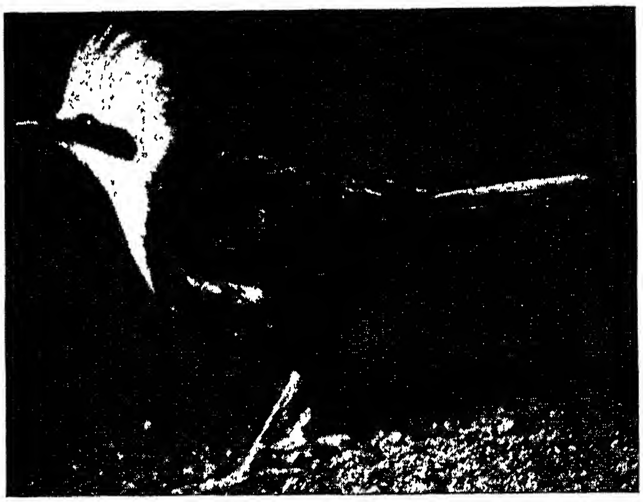
But even this record is easily eclipsed by the koel, which is parasitic upon the house crow. I once found no less than seven koël's eggs in one crow's nest, apparently the produce of three different koëls There were no crow's eggs, and I can only assume that the hen crow had given up the unequal struggle. The koël does not remove crow's eggs and is further peculiar, if not unique among cuckoos, in laying a very much smaller egg than that of her victim, though in general colour and markings it somewhat resembles the latter. The parasitism of the koël upon the crow is the more remarkable from the fact that the cunning of the Indian house crow is probably unequalled in any other bird, and those acquainted with its mentality would consider it the most unlikely bird to be imposed upon Yet, when it comes to incubation, the crow seems to be perfectly willing to sit upon anything, and has even been known to try to hatch a golf ball!

A detailed account of the habits of the house crow would fill a small volume, and those who are interested cannot do better than study the works of "E H. A." (the late E. H. Aitken), if they desire information combined with a keen sense of humour. I will pass on, therefore, to some notes on the crow's near allies, the jays, magpies, and tree-pies. Several species of jay are found in Burma, of which Oates' jay and the Burmese jay so closely resemble the English bird in appearance and nesting habits that both the birds and their eggs are practically indistinguishable except to the ornithologist. But a curious habit of the Burmese jay is its fondness for breeding in colonies. The birds do not form a rookery, but if one nest is found, it is a certainty that several more will be discovered within an area of a hundred square yards, while the next nesting colony will be several miles away.

In the heavy evergreen forests [illegible] the extreme south, Tavoy and [illegible]ergui, the rare b[illegible]ck jay, a [illegible]alayan bird, is [illegible] be found. [illegible] is jet black exc[illegible] for a small [illegible]ite patch on th[illegible]ng, but its [illegible]gs are indistin[illegible]able from [illegible]ose of the Eng[illegible]y. I took the first au[illegible]imens ev[illegible], a clutch of four, from a [illegible]t in a ca[illegible]id almost impenetrabl[illegible]The lo[illegible]agpie is peculiar in [illegible]g pig[illegible]plumage, which chang[illegible]vid g[illegible]greenish-blue after [illegible]e me[illegible]e colour in life, and [illegible] I found that the co[illegible]ied skin. Finally, th[illegible]ket-tailed magpies, of[illegible]nvariably places a do[illegible]the black magpie mak[illegible]composed of tendrils. [illegible]

While on[illegible], it is of interest to [illegible]dentified at sight by[illegible]material, though ma[illegible] in their tastes. Th[illegible]r uses anything b[illegible] certain creeper, and [illegible]hat the nest can be[illegible]f other bulbuls, wh[illegible]to what they use. [illegible]Burmese swallows us[illegible]-shaped nest with a[illegible] length. Austen's cro[illegible]ow fibre to form its c[illegible]nything else, while th[illegible]odgson's frogmouth, m[illegible]per side of a branch c[illegible]s. The crested swift[illegible]he side

of a twig, just sufficient to hold the single egg, which the bird incubates with its breast feathers as it sits on the twig. Most highly specialized of all are the nests of the grey-rumped swiftlet, the ingredients of "birds' nest soup," which are pure silvery white and are nothing but the inspissated saliva of the birds.



THE WHITE-CRESTED LAUGHING THRUSH.
This bird is a victim of the red-winged crested cuckoo, the commonest parasitic species in Burma. Three cuckoo's eggs were once found in a laughing-thrush's nest

Other birds, which do not use a specialized material, will go to infinite trouble to obtain some particular embellishment which apparently serves no useful purpose. The beautiful Penduline tits of the hills, which make a nest exactly like that of the English long-tailed tit, always line their nests with the bright metallic feathers of the rare Hume's pheasant, while the common house myna, which makes a nest of rubbish in a hole, always uses sloughed snake skin as a bed for its blue eggs. Most of the sunbirds use the dried droppings of caterpillars to adorn their hanging, purse-like nests, while the forktails line their nests with skeleton leaves, and the broadbills hang pendulous ornaments, leaves, twigs, even dead flowers, to their hanging nests. These, by the way, are always full of dead leaves, the reason being that the birds pluck fresh leaves daily, and place them under the eggs while incubation is proceeding, probably with a view to providing moisture.

Barely a year passes without some unusual nesting sites of our common British birds being recorded, but apart from freak sites, such as the nest of a house sparrow, which I once found built into that of a kite, some of the sites habitually used by Burmese birds are very remarkable. Thus the Rufous woodpecker always makes use of the nests of a tree ant in which to lay its eggs. Tree ants are extremely common, in fact hundreds of their nests may be seen daily in the forest, and are papier mâché spheres resembling wasps' nests. The woodpecker punches a hole, scoops out a cavity, and lays its eggs in the hollow. Probably it eats the ants; at any rate, ants are never found in a nest tenanted by a woodpecker, whose scaly plumage is probably impervious to attack.

The great stork-billed kingfisher also frequently, though not invariably, tunnels into the huge mud heaps of termites, although in this case the insects do not evacuate the nest, neither do they molest the kingfisher, possibly as there is room for both. As the large ants of the tropics frequently attack and devour eggs and fledglings of small birds, and as white ants will eat anything except glass, it is remarkable that the woodpecker and the kingfisher can use ants' nests for their own nesting operations with impunity. On the other hand, some birds undoubtedly can live in harmony with ants, and the golden weavers, for instance, often make their nests in bushes inhabited by a particularly ferocious tree ant, probably obtaining some measure of protection from these pugnacious insects. I have never been able to discover the particular enemy of the golden weavers, but they always seem to seek some form of protection. If stinging ants are not available, they will choose the thorniest bushes they can find, and are not even averse from the protection afforded by human beings, as they will build within a few feet of a house if a garden is available reasonably near the swampy land which is their natural habitat.

British ornithologists are, of course, well acquainted with the floating nests of the grebes, and the little Indian grebe exactly resembles the common dabchick in its nesting habits. But the jaçanas go even further in this direction, merely arranging a few pieces of water weed on a lily pad and laying their eggs on it, actually in the water. Incubation must be very largely due to sun heat, possibly assisted by the rotting vegetation, as in the case of the Nicobar megapode, whose eggs are hatched entirely by heat so generated. Young jaçanas can neither swim nor dive immediately after hatching, and spend the first few days of their lives chiefly on their mother's backs, though after a short time they can submerge with the facility of a submarine. The analogy is apt, since they do not dive as a duck does, but appear simply to sink in the water; they can remain under, clinging to the weeds, for a considerable time.

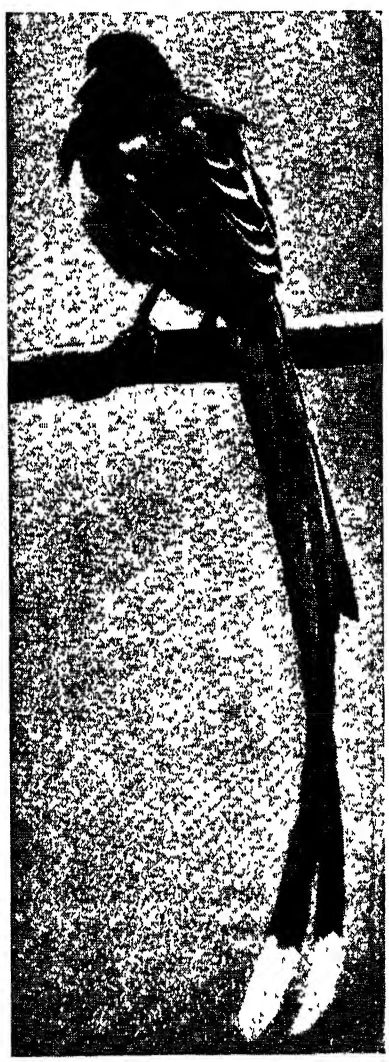
Oologists in India were baffled until quite recently by the spine-tails, members of the swift family, and believed to be the fastest-flying of all birds. I have seen a falcon stoop at a spine-tail and miss it by yards. It has recently been discovered that these

birds lay their eggs on the rotten wood at the base of hollow trees, entering perhaps fifty feet from the ground and descending the chimney. Possibly the most peculiar of all in their nesting habits are the hornbills. The nesting site is a cavity high up in a tree, and when the female has laid her eggs, both birds co-operate in immuring the hen by means of a viscid plaster consisting largely of the birds' own droppings, a narrow slit only being left through which the sitting bird is assiduously fed by her mate As many species of hornbill moult throughout incubation, and most of them are incapable of flight during the process, the walling-up is probably designed as a protection for the hen bird, though one would have thought that the enormous beak with its jagged mandibles would prove sufficient weapon to enable so powerful a bird to cope with most intruders

Of all my experiences, that which gave me the greatest satisfaction was the discovery of the masked finfoot's nest. This is one of the rarest of Eastern birds, belonging to the small and aberrant order of the Heliornithidae, whose only other representatives are a single species found in West Africa and two species inhabiting South America. The masked finfoot has the head and beak of a moorhen, the body and legs—which are apple green—of a duck, and the half-webbed feet of a coot. It can run, swim, or fly with equal ease, and its exact position in systematic classification was a matter of considerable doubt before the discovery of its eggs. The credit of taking the first nest belongs to two members of the Forest Service, who, acting under my instructions, succeeded in discovering the breeding place of these birds in the dismal swamp forests at the head of the Rangoon River. The nest is like that of a moorhen, placed upon a low branch trailing in the water, and the eggs, six or seven in number, are nearly spherical, and beautifully marked, their colouration placing the bird definitely among the rails.

While it is impossible in a single article to do more than touch upon some of the more striking peculiarities of bird life in Burma, no account should omit some allusion to the game birds, in which Burma is exceedingly rich Over twenty species of duck, mostly migratory, have been recorded, while terrestrial game birds are very numerous, ranging from the tiny "button" quail to the peafowl and Argus pheasant. During the winter, large numbers of migratory duck are to be found on the lakes and jheels of the Irrawaddy and Chindwin valleys in Northern Burma. I have seen the Paungbyin Lake literally black with wildfowl, and when the first shots were fired, the noise of their wings as they rose from the water resembled the roar of an approaching express Within a few seconds, there must have been fully ten thousand birds in the air. Pintail, spot-bill, gadwall, common and Garganey teal contribute chiefly to the bag, which in certain favoured localities also contains a large number of grey-lag geese. I was once fortunate enough to see the inward migration of these birds down the Chindwin valley, at the end of October. During the last hour of daylight, the skeins were passing high over my camp at intervals of a few yards, and as far as the eye could see up the valley, the air was full of geese. After dark, their gaggling could be heard till about nine o'clock which meant that the birds were streaming in for three hours; this lasted for three nights. I do not venture to estimate how many birds passed down the valley, and the only flight I have ever seen to compare with this was an endless line of storks crossing the Gulf of Suez, a procession which continued as long as the birds were visible from the ship's deck—almost two hours—and it is impossible to say how many had gone before or followed after.

Snipe, both pintail and fantail, are very plentiful from August to March. A peculiarity of the pintail species is its fondness for feeding on insects on bone dry ground; the fantail, on the other hand, never leaves the swampy land with which snipe shooting is ordinarily associated. In the Upper Chindwin, peafowl occur in great numbers, and in the extreme south the gloriousArgus pheasant is found.

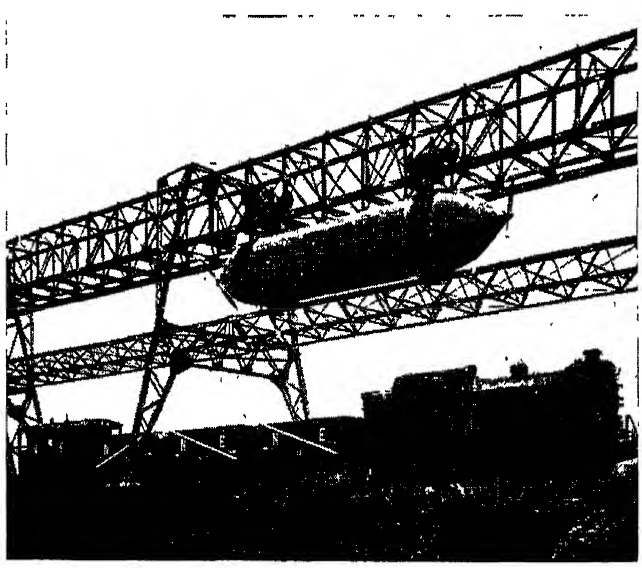


A THREE-FOOT TAIL.
The red-billed blue magpie is only the size of the English species, but its tail is three feet long.

120 Miles an Hour by Train?

The demand for faster travel raises the problem of separating fast-moving traffic from slower vehicles either by aerial or subterranean means. A new overhead "railplane" system of transport aims at a solution of the problem, while avoiding the unsafety of the air and the expense involved in constructing tunnels.

THE possibility of travelling at 120 miles an hour by rail is foreshadowed by the recent installation of the George Bennie "railplane" system at Milngavie, near Glasgow. An experimental track of slightly over four hundred feet has been erected over a disused siding, where successful experiments have already been carried out Zeppelin-shaped cars are suspended from a rigid overhead structure, and the means of propulsion is provided by air screws. In order that friction may be reduced to a minimum, single overhead rails have been adopted and ball-bearing devices have been fixed to all rotating parts. With one exception, there are no new principles involved in the system, and there are, therefore, no unknown factors which require to be demonstrated. It is intended to operate the lines by automatic electric signalling, the rotation of the motors being reversed when a clear run ahead is not available. The overhead track is carried on trestles or columns placed at intervals, and a rigid guide rail is provided under each car to prevent undue swaying. The bogies have been designed to check any tendency of the car to rise into the air.



RAILPLANE AND RAILWAY.
The system is designed to afford safe and rapid transport for passengers and light goods only, and is not intended to act as a substitute for railways.

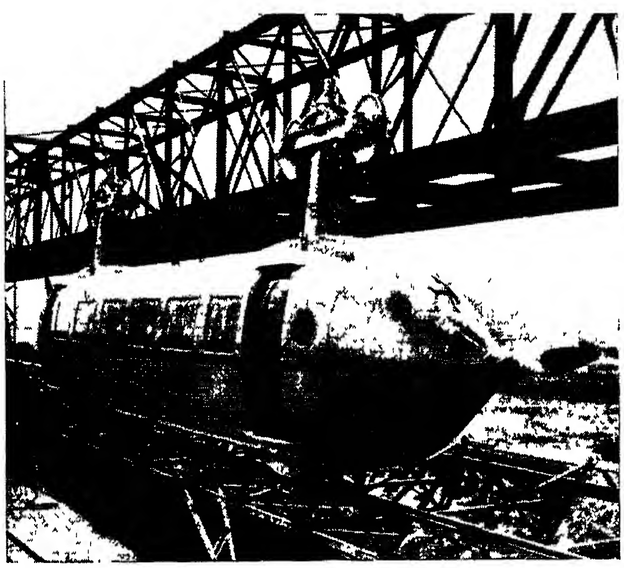
Propellers are placed on the front and rear of the car and are driven by an electric motor, the current being derived from a live rail. Where electric energy is not available, internal combustion engines are used, but the power depends, of course, on local conditions. In order that the alignment of the track may follow the configuration of the land, and thus render possible the selection of a track which will reduce construction costs to a minimum, the principal of suspending the cars at two points from bogies has been adopted. The bogies themselves have a very small wheel-base, so that the cars may be capable of ascending and descending gradients considerably more severe than those met with in the case of railways. The inventor points out that it would thus be possible to construct the line to follow closely the contour of the land, and would dispense with the cost and labour of tunnelling. Where aesthetic considerations render it advisable or necessary, the construction of the trestles and overhead work would be designed to meet the requirements. The structural work would normally be of steel, but if the conditions prevailing called for alternative methods, reinforced concrete, timber or a combination of the two might be employed. It is suggested that an elevated roadway or footpath for pedestrians might be provided above the railway track.

The following comparative costs of constructing the "railplane" system as compared with the normal type of railway are interesting. It is estimated that the cost of constructing one mile of double lines of the normal type is £47,500, while the cost of building one mile of double lines on the "railplane" system is calculated at £19,000. A double line of tube railway costs approximately £800,000 per mile, while one mile of double lines of the normal elevated railway costs £135,000. The cost of constructing the new overhead system, therefore, compares favourably with the corresponding expense entailed in the construction of normal railways. Painting the structural steelwork would be the most important item involved in the cost of maintenance, but it is estimated that the

expense involved in maintaining the overhead tracks, guide rails, automatic signals, stations and accesses would not exceed £300 per mile per annum. Each car would be under the control of one attendant, and the exit gates and signalling and safety devices would be controlled automatically; wages would therefore be maintained at a minimum.

Assuming that the line were level and that, by the use of ball-bearing devices for all rotating parts, the friction could be reduced to five pounds per ton load, the total friction to be overcome in putting a car into motion would be fifty pounds. Assuming, in addition, that the car were ascending an incline of one in thirty-five, with a minimum horse-power of 120, the speed which could be attained would be 50 miles an hour. With an average horse-power of 120, and a maximum of 240, speeds of 120 miles an hour could, it is claimed, be attained on the level or on a decline.

The "railplane" system has been devised to meet the demands for safe and rapid transport of passengers, mails, newspapers and perishable goods. Rapid travel is at present confined to air transport, and recent events have emphasized the uncertainty with which it is still attended. Weather conditions, too, help to militate against comfort in air travel, while the bulk of an airship necessarily limits its carrying capacity. At the same time, it becomes increasingly clear that fast traffic must be separated from slow-moving vehicles, and the problem calls either for aerial or subterranean means Aerial railways, as distinct from the elevated type, have so far been confined to the rope system which, while comparatively cheap in the initial outlay, is unsuitable for adaption to rapid transport. Elevated railways are undoubtedly costly, but whether the lines are worked by steam or electricity, the cost of travel is comparatively low compared with the existing railways.



A ZEPPELIN CAR.
The cars are suspended from a rigid structure which is carried on trestles or columns placed at intervals. The means of propulsion is provided by air screws.

INTERIOR VIEW
This view of the interior of one of the cars was taken after a recent test, and includes Mr George Bennie, at the extreme end, and several other railway experts.

The essential requirements of a high speed railway track are, of course, absolute safety and comfort at all speeds, freedom from lateral oscillation, stability which is independent of any mechanism such as gyroscopes, and, lastly, that centrifugal and wind forces should not be concentrated in a single line. An expert recently stated that the normal type of twin-track construction does not fulfil the second and last conditions, and that the first condition is only complied with at speeds not exceeding seventy or eighty miles an hour. These conditions would be fulfilled, he said, if the track took the form of an upper and lower line of rails, one immediately below the other. Whether the upper or lower rail were used for carrying the weight of the vehicle would be relatively unimportant. This authority on railway problems has stated that the "railplane" system fulfils the four conditions required as far as can be judged at present.

The new system is not intended to act as a substitute for the existing railways; heavy and bulky traffic could not be conveniently dealt with. It has been designed to afford safe and rapid transport for passengers and light goods. The system is still, of course, largely in the experimental stage, and, owing to the shortness of the existing track, it has not been possible to test the maximum speed of the car. The experiments have so far proved highly satisfactory, however, and there is little doubt that the installation will open up greater possibilities for faster travel in the future.

Book Reviews.

The Mysterious Universe By SIR JAMES JEANS. (Cambridge University Press. 3*s*. 6*d*)

It is interesting to speculate on the reason for the universal popularity of such scientific books as this. Nothing is more certain than its existence. For example, the remarkable success of that beautiful book "The Universe Around Us" is evinced by the fact that more than 40,000 copies have been sold. That the man with some, even slight, scientific training should be anxious to read modern astronomical and physical books is understandable, but the public which demands such literature extends far beyond this comparatively small circle The answer is probably to be found, not in popular scientific interest entirely, but rather in the dominating philosophical curiosity which is fundamental in human consciousness.

Be the cause what it may, it is gratifying that such men as Sir James Jeans are available and willing to answer this insistant demand Writers who combine the most profound learning with exquisite clarity of expression are very rare; but it is only they who should be entrusted with the great responsibility, for it is very great, of teaching the true meaning and progress of science to the multitudes who seek from science an answer to the enigma of life It is the business of the philosopher to answer the question "Why?" It is a function of science to tell him from time to time all she knows concerning the phenomena of which she has taken cognizance. This is the view put forward by the author in his preface, and the book is an attempt to explain in simple language the *scientific significance* of the findings of modern physics.

Sir James Jeans very rightly lays considerable stress on the intangibility of many modern scientific views, and points out that many words freely used in scientific discussion have nothing at all but a mathematical meaning. The space-time continuum of relativity, the photon, or energy quantum of Planck, and even that familiar concept the electron, are all convenient mathematical images and nothing more. With the advent of wireless and the many familiar uses of X-rays it has become customary to discuss wave-motion almost as if it had the same objective character as a storm at sea This habit was all very well in the more materialistic days of scientific history, when ingenious attempts were made to invest an ether with mechanical attributes; but Sir James Jeans shows with undeniable reasonableness that the coming of Einstein of necessity meant the final departure of the Victorian ether. In its place we have now a four-dimensional continuum which is again a mathematical abstraction, it may be thought of, the author suggests, as a "framework in which to exhibit the workings of nature"

It is interesting to observe that, in spite of the materialistic attitude of the Victorian scientists who sought so assiduously for a mechanical explanation of the universe, a great exponent of modern science, like Sir James Jeans, expresses practically the same view as was expressed by the great Newton. He says in his tentative but very charming final chapter: "If the universe is a universe of thought then its creation must have been an act of thought, indeed the finiteness of time and space almost compel us, of themselves, to picture the creation as an act of thought. . . Modern scientific theory compels us to think of the Creator as working outside time and space which are part of His creation, just as the artist is outside his canvas." Sir Isaac Newton, writing some two hundred and fifty years ago, said: "The business of natural philosophy is to argue from phenomena and to deduce causes from effects till we come to the very first cause, which certainly is not mechanical"

The author is most careful to warn his readers that they must not regard modern scientific pronouncements as possessing any degree of finality, for he says· "Who knows how many more times the stream of knowledge may turn on itself?" Maybe the greatest triumph of modern science is that she realizes that her conclusions are frankly speculative and uncertain

To add conventional words of praise for this book would be banal, indeed, it would be almost impertinent

V. E PULLIN

The Flight from Reason. By ARNOLD LUNN. (Eyre & Spottiswood. 7*s* 6*d*.)

There is no doubt that Mr Arnold Lunn is a very attractive writer and, moreover, is master of a great deal of information. The scientific reviewer, however, cannot help wondering what it is all about On the cover of this book we are told that Mr Lunn examines the case against religion as put forward by leading scientists from Darwin to J. B. S. Haldane It appears to the reviewer that, like Denmark's queen, the author protests too much. The main portion of the book is given up to a spirited vindication of Theism as opposed to Darwinism and particularly Charles Darwin. It is difficult to understand why such a modest and painstaking scientific observer as Darwin should have aroused such able and devastating criticism as that launched by the author of this book. . To an ordinary observer, unlearned in the technicalities of evolution, but one nevertheless who takes pleasure in following the history of science on broader lines, it would appear that it was Ernst Haeckel rather than Darwin who was responsible for the philosophical development of Darwin's teaching, which appears to arouse the ire of Mr. Lunn. From the point of view of scientific progress, surely Darwinism performed a most valuable function as the starting-point of many branches of allied observation, quite apart from its effect on any theological system or even its own scientific merit

Mr Lunn accuses nineteenth-century science of many evils. There can be no doubt that the materialism which developed generally as a result of nineteenth-century scientific activity was, according to our present views, deplorable Nevertheless, we must be careful that in condemning one aspect of a vast piece of progress, we do not include all the valuable work that was carried out during this period We must remember with gratitude the work of physicists like Lord Kelvin, Young and Helmholtz, psychologists like Alexander Bain and E H. Weber, and a host of others who did pioneer work in the realm of pure science.

Unfortunately, in the minds of a great many people, there seems to be an inherent antagonism between religion and science. But most modern scientists (I hope they do not all fall under Mr. Lunn's displeasure) hold similar views to those expounded by Sir James Jeans, and it is difficult in these days to find a true scientific atheist On the other hand, there are many "genuine agnostics" with whom I am relieved to learn Mr. Lunn has no serious quarrel. These are men who are content to suspend judgment on such weighty matters as the relative importance of close religious systems, but nevertheless men who seize with avidity upon all valid evidence which may help them in their never-ending quest for truth.

There is no doubt that Mr. Lunn's book is interesting and makes enjoyable reading, although it contains many statements which convey the impression that the zeal of the author outruns his sense of proportion One cannot help feeling that his talent would have been more attractively employed in dealing with subject matter of more vital import

V E PULLIN.

The Romance of Archaeology. By R V D MAGOFFIN and EMILY C. DAVIS (Bell & Son 18s).

This book, in the words of the authors, makes "no pretence to the meticulous scholarship that must document every statement," and its aim is to interest and amuse the general public With so disarming a preface it would be unkind for a reviewer to complain But the reader at the start should be warned that in those chapters of which Mr. Magoffin is the author a series of wholly unnecessary blunders will be found Bokhara (p 25) is not in India; Professor Doerpfeld has never maintained that Corfu was Ithaca (p 28), china was not made at Cnossos (p 103); nor was the bath found at Mycenae the authentic *Blutbad* of Agamemnon Nor do archaeologists accept the coinage of Demetrius Poliorcetes as representing the attitude of the Victory of Samothrace (p 157), while many people seriously doubt the attribution of the Hermes of Praxiteles as an original (p. 158). Remembering, then, that the authors neither claim nor exhibit an accurate knowledge of archaeology, we can take the book at its face value, the whole making an agreeable volume to read in a train

The illustrator who was let loose on the book must surely have come from Hollywood, to see added to a description of a silver drachma of Athens the remark that its design "has long been used as the colophon of Henry Holt and Co", and to read "A King's Permanent Wave" as a caption for the gold helmet of Ur, create a certain doubt in the reader's mind as to the likelihood of the full value of the remains of antiquity being realized by the authors

But it must be admitted that the chapters on the archaeology of America, written in a more sober vein by Miss Davis, are simple, clear and interesting, particularly to English readers So, too, the chapter on Norse archaeology and upon that of the British Isles is straightforward and tolerably accurate.

In a book which covers all the most important archaeological discoveries of Greece, Italy, Mesopotamia, India, America, and most of the European countries, one is surprised to find no mention of the astonishing discoveries at Turfan in Central Asia or of the expeditions of Sir Aurel Stein And since sensations are the authors' life blood itself, one is surprised to see no mention of the discovery at Delphi fifteen years ago of the archaic Omphalos, the true centre of what Mr Magoffin calls "the stunning figure of Hellenism" But for one unforgettable phrase I am eternally grateful—"Out in Mesopotamia," says our intrepid author, "B C is nothing!"

STANLEY CASSON.

An Introduction to Biology. By G. W GIDEON, M A., Lecturer in Biology at Karnatak College, Dharwar (Students' Book Depot, Dharwar. Rs. 9).

For an English reviewer the special interest of this book is that it deals with the types used in India by medical students of elementary biology. It is pleasantly unfamiliar to find Pheretine in the place of Lumbricus and Panulirus—that borogrovian etymological curiosity—instead of Astacus.

The author does not intend this work for a textbook, but simply as a laboratory guide to supplement and co-ordinate the knowledge derived from lectures. It is of unusual dimensions, being approximately folio size. This format is rendered necessary by the purpose of the book, which is to present to the eye charts of the types opposite to the letterpress These diagrams are well drawn and labelled, but it is a pity there is not a series illustrating mitosis. They should help an examination student very materially The text is accurate, though the total omission of excretion under metabolism is an omission, and not all systematists admit the Ctenophora as Coelomata There are an excessive number of printer's errata (*e g*, blasocoel, progneata) due to the small centre at which the book is printed, but the recurrent Paramoecium does not come under this heading. Such a spelling is impossible in a word derived from the Greek *para mekos*

Though in no way comparable to Howes' invaluable Atlas for English students, the work should serve its special purpose admirably The author states that he has found that Indian students at the end of their course have only acquired a mass of undigested and unrelated facts. He hopes by the help of the notes in his book to give them a more comprehensive view of the subject as a whole. None the less zoology cannot be learnt from this or any other book. This book gives the necessary facts of biology for a particular examination, so arranged that they can be easily remembered and used in an examination. Incidentally, as it makes this process easier and quicker, so it should set free time for a real study of the subject as apart from cramming.

Whether a cram knowledge of elementary zoology serves any more useful purpose for Indian medical students than it does for similar students in Great Britain, is the business of those responsible for the preliminary education of medical men. The whole question of the scope and nature of the preliminary biology for medical students seems ripe for reconsideration both in Britain and India.

ARCHER VASSALL.

Aviation of To-day: Its History and Development. By J. L. NAYLER, M.A., and E OWER, B.Sc. (Warne. 15s.).

This fascinating book is more than a mere addition to the many historical accounts which have been written about the development of aviation. The authors survey the subject on very broad lines, and have aimed at presenting the fundamental principles upon which flight has been built up and at showing how these principles have been applied in the design and operation of lighter- and heavier-than-air craft. Finally, some of the achievements which have marked the progress of flying are described, and the possibilities of the future are predicted. The development of aviation is traced primarily on technical lines, but the story is presented in a manner which is interesting and intelligible to those who are not experts in flying, and there is a sufficient flavouring of historical interest to relieve the inevitable heaviness of some of the technical descriptions. The authors have wisely included a chapter on aeronautical science, in spite of the essentially "popular" nature of the book. Their work would not have been complete without it, since probably no branch of engineering owes more to scientific research than aviation. This chapter is necessarily rather more technical than some of the others, but it is certainly one of the most interesting.

In view of recent events, the chapter on the flying, handling and airworthiness of airships is more than usually topical, and the subject is dealt with in some detail Discussing gaseous fuels in airships, it is pointed out that liquid fuel has an advantage over gaseous fuel in that the former can be used as ballast in cases of emergency. Another point to be borne in mind is that, should the airship enter an ascending current of air and be borne upwards, near the beginning of a flight when the fuel bags are almost full, some of the fuel may be lost in expansion, just as is the case with hydrogen in the same circumstances. This may lead to a considerable reduction in the range of the ship. Probably, therefore, some reserves of petrol or other liquid fuel will always be carried when the engines operate mainly on gas fuel. It is not possible, the authors write, in the present state of development, to predict what will be the standard mode of operation in the future. The efforts to develop a practical means of burning a hydrogen and liquid fuel mixture may, if successful, find some favour. When helium is used as the buoyancy gas, the problem of avoiding wastage becomes more acute, in view of the higher prices as compared with hydrogen. In this case, since helium is non-inflammable, there are only two alternatives known: water recovery and the use of gas fuel The book was already in the press when disaster overtook the R. 101, and the accident is not, therefore, discussed. The book contains over two hundred illustrations, many of which are in colour.

The Paris Gun. By H. W. Miller. (Harrap. 10*s*. 6*d*.).

Probably the most striking even of the late war was the bombardment of Paris in 1918 by the German long-range guns, the most familiar of which was "Big Bertha," or the Paris gun. It will be recalled that, in the Treaty of Versailles, the allies demanded that one of the long-range guns should be delivered with full information concerning its design and use, and that neither, in fact, was ever received. This book is the result of ten years' persistent search in places "which were thought safely secret," and Colonel Miller "now presents the full story of the Paris gun in its proper setting." The book is yet another addition to an already copious list of war books, but it is of considerably more scientific interest than most and is a refreshing departure from the conventional mud-and-blood account. The excitement in Paris, the experts' attempts to "spot" the guns, and the difficulty which they found in discovering their position are already well known. The chief interest of the book lies in the glimpse which it affords of the German side of the operations: the planning of the guns, the construction of emplacements, the elaborate precautions to conceal them, and the careful calculations which had to be made in connexion with firing.

At 7.17 on the evening of 23rd March, the Paris gun fired its first shell. A pressure of a million pounds was exerted on the base of the shell as it left the muzzle, and within one-fiftieth of a second it was travelling at a velocity of one mile per second with the energy of a billion foot-pounds. Within twenty-five seconds, the shell had attained a height of twelve miles, and sixty-five seconds later it was at its maximum height, twenty-four miles. At 7.20 the shell burst. "Big Bertha" was unique; in no previous gun had such instruments as pressure gauges been used to discover the probable point in range which the shell would strike, or to correct the calculated weight of the powder for the next charge. After firing the first shell, the gauges were opened, and the cylindrical pellets of copper were removed and measured with a micrometer gauge. When the gun was fired, the pressure of the gases forced a piston into the copper, thus crushing it slightly. The reduced length of the copper pellets indicated the maximum pressure of the gases in the gun for the first shot. According to the range table, the pressure should have been 59,000 pounds per square inch for the corrected range of 67.1 miles, but the gauges showed that the pressure had only been 53,800 pounds. Seven and a half pounds of powder were therefore added to the variable powder charge, and the bag was sewn up for loading a second time This concluded the first day's long-range bombardment of Paris.

The Wild Grizzles of Alaska. By J. M. Holzworth. (Putnam. 21*s*.).

Hunting the Alaska Brown Bear. By J. W. Eddy. (Putnam 15*s*.).

Mr Holzworth has made several visits to the Alaska Islands, where he has studied the habits of the grizzly bears, and his book throws interesting new light on the temperament of an animal about which little is really known. The recent action of the Alaska Game Commission in removing all restrictions on the slaughter of bears, has prompted the author to make a plea for "fair play" on behalf of "a courageous and noble animal who is widely misrepresented and slandered." The book is divided into three parts. The author first describes the geographical features of the Alaska Islands, and then passes to a classification of the local species and their habits. In the third part, methods of taking motion pictures are discussed, with some notes on mountain caribou and sheep.

"It is from his courage," Mr. Holzworth writes, "that the bear has received a reputation for ferocity." But, according to the author, the animal is essentially prudent, and unprovoked attack, despite assertions to the contrary, is extremely rare. Nearly every instance when a bear has injured a hunter can, apparently, be traced to one of five causes. Either the bear has been seriously wounded but not, owing to bad markmanship, completely disabled, or he has been shot at on a previous occasion and consequently regards man as his enemy. A hunter who is carrying venison may attract a bear owing to the strong scent of the meat, or the animal may be encouraged to give chase when the hunter turns and runs from him. Lastly, an attack is sometimes due to sudden surprise.

Mr. Eddy's book naturally has much in common with the first book under review, but there are several well-defined differences Mr. Holzworth was chiefly concerned with a study of the psychology and habits of the bear, and his book is therefore possibly of more scientific interest than the second book, which is mainly an account of a hunting expedition. The first author makes a plea for the preservation of the bear, while Mr Eddy's "brought home that supreme trophy of the sportsman, the pelt of the big brown bear." Lastly, Mr. Holzworth writes of the grizzly while Mr. Eddy describes the brown bear. Both books are profusely illustrated with extremely bad pictures.

The Garden of Enchantment. By Sydney T. Klein. (Rider. 4*s*. 6*d*.).

The title of this little book is, perhaps, sufficient indication of its contents. The author has made a life-long study of nature in the Fairyland which is his garden, and while the book is doubtless primarily intended for children, Mr. Klein's keen observation has enabled him to set down much that will be of interest to older readers.